Compilation of the Evaluations of Doctoral Thesis (Human Kinetics) - Student: Nicholas Ali (5033260)

Thesis Supervisors: Gordon Robertson and Gholamreza Rouhi

Evaluation	Examiner C Daniel Bénoît	Examiner B Michel Labrosse	Examiner A Edward Lemaire	Examiner D (external) Graham Caldwell	Second external (following withdrawal of D. Bénoît) M. Pierrynowski	
1st evaluation **January 2012**	Verdict # 4	Verdict # 2	Verdict # 3	Verdict # 3		
Result 18 January 2012	Dean informs student that he must register and revise his thesis during the Winter 2012 session					
2nd evaluation using form for a first evaluation* **Oct-Nov 2012**	Withdrew (7 Aug 2012)	Verdict # 1	Verdict # 3	Verdict # 3	Verdict # 3	
2nd evaluation using form for a revised thesis*		Verdict # 1	Verdict # 3	Verdict # 2	Verdict # 3	
Final result **30 January 2013**	Dean of FGPS notifies student that his revised thesis still fails to meet the standards required for the degree and that he must withdraw from the program.					

* The examiners were sent, in error, the form to be used for the first evaluation of a thesis. The form for a revised thesis makes it clear that if more than one examiner chooses verdict # 3 or # 4, the student will have to withdraw.

See next page for a description of the verdicts on the form for a revised thesis

FGPS regulation G

<u>CRITERIA:</u> DOCTORAL THESIS: The thesis must constitute a significant contribution to knowledge, embody the results of original investigation and analysis by the student and be of such quality as to merit publication.

FGPS regulation G.5.2 (a)

A thesis may not be defended if two examiners are opposed. If one of the examiners has serious reservations concerning the thesis, the matter is referred to the dean of the FGPS. A candidate whose thesis is not recommended for the defence following a second reading must withdraw from the program.

<u>FORM for revised thesis :</u>

Verdict # 1: The revised thesis is accepted for the defence.

- Meets criteria listed above.
- Required changes are limited to correcting occasional grammatical or spelling errors, formatting problems or minor redundancies or omissions.

Verdict # 2: The revised thesis is accepted for the defence but additional changes are required <u>AFTER DEFENCE</u>.

- Quality of the presentation is acceptable and necessary changes will not have an impact on the defence.
- Jury will determine which additional changes are necessary and who will be responsible for ensuring they are completed and approving the thesis.

Verdict # 3: The revised thesis still cannot be accepted for the defence and must undergo additional extensive revision <u>BEFORE DEFENCE</u> to ensure it meets the above criteria.

- There are still problems with the interpretation of results or the theoretical or methodological approach, but the thesis may meet the criteria if substantial changes are made.
- The presentation of the revised thesis is still not acceptable (numerous grammatical or spelling errors, evidence of carelessness, etc)

In this case, the revised thesis is returned to the candidate to complete additional revisions and submit a new revised version to examiners. Examiners must judge changes satisfactory before thesis can proceed to defence stage.

If more than one examiner chooses this verdict for the revised thesis, the student must withdraw from the program.

Verdict # 4: The revised thesis still fails to meet the standards required for the degree.

- The work was not done in accordance with established methodology employed in the discipline.
- The thesis still does not exhibit the candidate's capacity to meet the scholarly standards required.
- Even with additional extensive revision, the thesis would not meet the standards require for the degree.

By choosing this verdict, the examiner recommends that the student withdraw from the program. If more than one examiner chooses this verdict for the revised thesis, the student must withdraw from the program.

Evaluation of the PhD thesis in Human Kinetics of Mr. Nicholas Ali (# 5033260) – Chronology

19-10-2011 – Initial submission of the thesis for evaluation

Dec. 2011 – Reports (first evaluation):

- E. Lemaire: #3
- M. Labrosse: # 1
- D. Benoît: # 4
- G. Caldwell (external): # 3

18-01-2012 – Dr. Hastings (interim dean of the FGPS) sent a letter to the student telling him that he had to reregister and revise his thesis during the Winter 2012 session.

19-04-2012 – The student sends a list of comments to Dr. Benoît, who finds them objectionable. Dr. Benoît reports this to Dean Hastings.

10-05-2012 – The student submits a revised version of his thesis along with a list of comments/changes (117 pages). The list bears his name along with that of his two supervisors.

14-06-2012 – Dean Hastings emails the student (with a copy to his two supervisors and Vice-Dean Sveistrup) regarding his concerns with the content of the "thesis reviewer sheets". He reminds the student that the thesis is his work and tells him that the names of his supervisors must be removed from the list of comments.

24-06-2012 – The student responds to the Dean's email, raising some concerns about the choice of two of the evaluators (E. Lemaire and D. Benoît). He enquires about the possibility of adding a second external. He also asks if there is a right of appeal at that stage of the evaluation.

03-07-2012 – The Dean responds on 24-06-2012 and informs the student that there is no appeal procedure at that stage of the evaluation. The revised version of the thesis must go through a second evaluation. If the thesis is not accepted for defence at this point, the student will be withdrawn from the program. The withdrawal can be appealed to the Executive Committee of the FGPS and, if the appeal is not granted, to the Senate Appeals Committee.

05-07-2012 – Submission of the revised thesis along with a list of comments/changes. The student confirms that he wishes this list and his revised thesis to be sent to the evaluation committee.

13-07-2012 – The Dean acknowledges receipt of the documents and confirms that they will be forwarded to the evaluators. He also informs the student that he continues to have some concerns about the list of comments/changes.

25-07-2012 – The documents are sent to the evaluation committee.

07-08-2012 – Dr. Benoît withdraws from the evaluation committee.

September 2012 – Receipt of the reports for the second evaluation:

- E. Lemaire: #3
- M. Labrosse: # 1
- G. Caldwell (external): # 3

It comes to the attention of the FGPS that the incorrect evaluation form has been sent to the evaluators. They should have received the form for the evaluation of a revised thesis but instead received the form for an initial evaluation. The correct form is sent to the evaluators, with a request to confirm their verdict. The verdicts are as follows:

- E. Lemaire: #3
- M. Labrosse: # 1
- G. Caldwell (external): # 2 (instead of # 3 as originally submitted on 20-09-2012)

The Dean decides to add another external evaluator.

03-10-2012 – The Dean informs the student and his supervisors that Dr. Benoît has withdrawn and that the thesis will be sent to a second external.

09-10-2012 – Dr. Robertson suggests the name of Dr. Pierrynowski (who was proposed as a potential external examiner when the list of examiners was initially submitted).

16-10-2012 – Dr. Pierrynowski agrees to evaluate the thesis.

18-11-2012 – Dr. Pierrynowski sends his report and gives verdict # 3.

In sum, the verdicts are as follows:

- E. Lemaire: # 3
- M. Labrosse: # 1
- G. Caldwell (external): # 2
- M. Pierrynowski (additional external): # 3

December 2012 – The student emails Dean Hastings to inform him that some of the articles, which are part of the thesis, have been accepted for publication.

10-12-2012 – The Dean calls Dr. Pierrynowski to ask if he confirms his verdict that the thesis is not ready for defence. Dr. Pierrynowski confirms this.

13-12-2012 – The Dean meets with the student and one of his supervisors, Dr. Robertson (the other supervisor is out of the country). The Dean summarizes the evaluations and provides the student and his supervisor with a copy of the evaluation reports. The Dean asks the student to review the reports and provide comments.

The supervisor asks that the thesis go forward to defence as he considers it to be ready. He informs the Dean that 4 papers out of the 5 included in the thesis have been accepted for publication.

17-12-2012 – Drs. Robertson and Rouhi email Dean Hastings to formally request that the thesis proceed to the defence.

19-12-2012 – The student sends an email to Dean Hastings to inform him that his supervisors sent their email of 17-12-2012 without consulting him and that he will send his response for the Dean's consideration in due course.

21-12-2012 – The student sends an email to confirm that he agrees with the request of 17-12-2012 of his supervisors.

22-12-2012 – The Dean replies that he will render a decision in early January 2013.

20-01-2013 – The Dean informs the student and his supervisors that he cannot recommend that the thesis go to defence citing FGPS regulation G.5.2 (a) which specifies that "A thesis may not be defended if two examiners are opposed."

21-01-2013 – Email from Dr. Robertson asking for a confirmation that the two evaluators who gave verdict # 3 considered that the thesis should not proceed to the defence.

22-01-2013 – Email from the student alleging that Dr. Lemaire did not intend to fail him (the student provides an attachment). The student requests the Dean to change his position and allow the thesis go to defence.

22-01-2013 – The Dean contacts Dr. Lemaire, who confirms his view that the thesis should not proceed to defence. The Dean had already contacted Dr. Pierrynowski in December.

24-01-2013 – The Dean re-iterates to the student and his supervisors that the thesis has not been approved for defence.

26-01-2013 – The student sends an email to raise concerns about the choices of Drs. Lemaire, Pierrynowski and Caldwell as evaluators.

29-01-2013 –The Dean confirms that his decision has not changed.

30-01-2013 – Email from the student attaching new documents concerning the choice of Dr. Lemaire as an evaluator.

30-01-2013 – Email from the Dean to the student: the decision remains the same.

01-02-2013 – Letter sent via email to the student, with a copy to his supervisors and the evaluation committee confirming the outcome, i.e. that the thesis does not meet the standards for the degree, that his file will be closed and letting him know his appeal options.

FIRST EVALUATION

uOttawa

Université d'Ottawa
Faculté des études supérieures
et postdoctorales
University of Ottawa
Faculty of Graduate and
Postdoctoral Studies

January 18, 2012

Mr. Nicholas Ali
306 – 589 Rideau Street
Ottawa ON K1N 6A1

Dear Mr. Ali:

The reports of the examiners of your doctoral thesis in Human Kinetics have now been received and I regret to inform you that your thesis must undergo **major** revisions in order to make it acceptable for the oral defence.

Enclosed, you will find a copy of the comments of the examiners; Dr. Daniel Benoit, Dr. Graham Caldwell, Dr. Michel Labrosse, and Dr. Edward Lemaire, which I believe will be useful during the course of your revision. Before proceeding with your corrections, I suggest that you discuss this with your supervisor. If you need additional clarifications, you may also contact your examiners. When completed, please list the changes made on a separate sheet and identify the corresponding page numbers in the original as well as in the revised version. Should you decide not to address some of the criticisms, it would be important to give the reasons for your decision in writing.

According to FGPS regulations, you will have to register for the **winter 2012** session (January-April) while performing your revisions. Please **complete and sign** the enclosed Graduate Registration form **including your classification (full or part time) and** send it by fax to the FGPS Registration and Records Section at 613-562-5992.

Five copies of your revised thesis must be submitted to the Faculty of Health Sciences by **April 30, 2012** for a re-evaluation by the same examiners.

Sincerely,

Ross Hastings

Ross Hastings, Ph.D.
Acting Dean

c.c.	D. Benoit	G. Caldwell	M. Labrosse
	E. Lemaire	G. Robertson	G. Rouhi
	B. Séguin	L. O'Reilly	N. Carter

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THESIS EXAMINER'S REPORT

NAME OF STUDENT	STUDENT NUMBER	DOCTORAL THESIS	MASTER'S THESIS
Nicholas Ali	5033260	[x]	[ ]

DEGREE	ACADEMIC UNIT
PhD	School of Human Kinetics

TITLE OF THESIS
"Predicting Risk Factors of Non-Contact Anterior Cruciate Ligament Injuries During Single-Leg Landing"

NAME OF THESIS SUPERVISOR	NAME OF THESIS CO-SUPERVISOR
Dr. Gordon Robertson	Dr. Gholamreza Rouhi
NAME OF EXAMINER	**DEADLINE FOR SUBMISSION OF REPORT**
Dr. Edward Lemaire	December 19, 2011

INSTRUCTIONS FOR EXAMINERS

PART A: EVALUATION / Tick off the choice that best describes your evaluation of the thesis.
PART B: COMMENTS / Provide your comments for each of the topics listed.
PART C: RECOMMENDATION FOR A PRIZE / Indicate your decision and complete the attached form if recommending thesis for a prize.
PART D: SIGNATURE / Sign and date the form
PART E: DOCUMENTS / Return necessary documents.

PART A: EVALUATION

CRITERIA

DOCTORAL THESIS: The thesis must constitute a significant contribution to knowledge, embody the results of original investigation and analysis by the student and be of such quality as to merit publication.
MASTER'S THESIS: The thesis should demonstrate that the candidate is able to work in a scholarly manner and is acquainted with the principal works published on the subject of the thesis. Insofar as it is possible, the thesis should be an original contribution.

VERDICT

1	[ ]	**The thesis is accepted for the defence.** • The thesis meets the evaluation criteria listed above. • Required changes are limited to correcting occasional grammatical or spelling errors, formatting problems or to minor redundancies or omissions (e.g., transitional paragraphs, notes).
2	[ ]	**The thesis is accepted for the defence but must be revised AFTER DEFENCE.** • The quality of the presentation is acceptable and the necessary revisions will not have an impact on the defence. • During the defence, the jury will determine which revisions are necessary and who will be responsible for ensuring they have been completed and for approving the thesis.
3	[x]	**The thesis cannot be accepted for the defence and must undergo extensive revision BEFORE DEFENCE to ensure it meets the above criteria.** • There are problems with the interpretation of results or the theoretical or methodological approach, but the thesis may meet the criteria if substantial changes are made. • The presentation of the thesis is still not acceptable (numerous grammatical or spelling errors, evidence of carelessness, etc.). In this case, the thesis is returned to the candidate to complete the required revisions, corrections and changes. The candidate must submit a revised version of the thesis to the examiners. The examiners must judge the changes satisfactory before the thesis can proceed to the defence stage.
4	[ ]	**The thesis still fails to meet the standards required for the degree.** • The work was not done in accordance with established methodology employed by the discipline. • The thesis does not exhibit the candidate's capacity to meet the scholarly standards required. • Even with extensive revision, the thesis would not meet the standards required for the degree. In this case, the candidate may be asked to withdraw from the program.

NOTE: Your feedback will have an impact on how the candidate prepares for the defence, the dean's decision if the jury is divided and the awarding of prizes. Please be sure to complete Section B regardless of your verdict.

PART B: COMMENTS

Please provide your comments on each of the topics below in a separate document. If the thesis is accepted for the defence (see verdicts # 1 and # 2, above), your comments will be sent to the candidate and the thesis supervisor without reference to your identity. If major revisions are required before the defence (see verdict # 3, above), a signed copy of your comments will be provided to the student, the supervisor, as well as to all members of the jury and the chair of the academic unit.

→ UNDERSTANDING OF THE SUBJECT MATTER
→ CONTRIBUTION OF THE THESIS TO ADVANCING KNOWLEDGE
→ RESEARCH METHODOLOGY
→ ANALYSIS OF RESULTS AND VALUE OF CONCLUSIONS
→ ORGANIZATION, WRITING STYLE AND PRESENTATION OF MATERIAL
→ REVISIONS CONSIDERED NECESSARY IN ORDER FOR THESIS TO BE ACCEPTED
→ GENERAL COMMENTS

Your comments and explanations are extremely important and will:

- help the student prepare for the defence or make necessary revisions to the thesis (if revisions are required before the defence, a <u>signed copy</u> of your comments is provided to the candidate, the thesis supervisor, as well as to all members of the jury and the chair of the academic unit);
- allow the dean of FGPS to make an informed decision if the jury is divided; and
- allow the FGPS selection committee to choose recipients of prizes and medals.

PART C: RECOMMENDATION FOR A PRIZE

Do you recommend this thesis for a prize?

☐ YES – Please complete the attached NOMINATION FOR THESIS PRIZE form.
☒ NO

The absence of a reply will be considered a NO.

PART D: SIGNATURE

DATE December 5, 2011 SIGNATURE

PART E: DOCUMENTS

Please return all documents by email to fssrecherche@uOttawa.ca or by fax to 613-562-5437 and send the originals in the enclosed self-addressed envelope to:

Assistant to the Vice-Dean, Research & Graduate Studies
Faculty of Health Sciences
Roger Guindon Hall
451, Smyth Road Room 3028
Ottawa ON K1H 8M5

Wm. Edward Lemaire

Nicholas Ali – Thesis Review

Overall

- Revise paragraph format
- Now much of the predictive nature of ACL injury is random and how much is predictable?
- The term "risk factors" is often used in a manner that leads the reader to question the appropriate use of this term. For example "To accomplish this a problem is defined and formulated to determine the instance where many risk factors, many forces, and other extreme conditions happen simultaneously to cause ACL failure." In my mind this includes environmental factors (ice, etc), footwear, medication, range of motion, balance, etc. More precise terms would be useful in many situations within the thesis.
- The first two papers try to build a rationale for an ACL research methodology, but this method was not used in the thesis. Therefore, should these papers be included in this thesis?
- Plantiflexion should be changed to plantarflexion throughout the document
- The word "gleaned" is used in the thesis. This can be changed, since the information is usually not "extracted from various sources" or "collected gradually and bit by bit"
- BW may be in N for paper 3 and Kg for paper 4 (Nm/BW*h). Please check and be consistent.
- Do not replace commas with dashes. For example. "statistics –not presented– one can observe" should be "statistics, not presented, one can observe"
- Since arms motion was removed from the task, this should be considered with discussing the results
- In paper 3,
    - Results must be clarified to indicate which results are linked to vertical, horizontal, or individual height analyses.
    - Results must be shown in tables for each height and distance condition (mean and SD)
- In paper 4,
    - The introduction talks mainly about the lack of literature but does not discuss the outcomes from the literature that does exist. This section needs to be rewritten to provide the reader with an overview of the existing literature on gender differences with single leg landing. This should cover both drop landing and jump to single leg lending since both topics are relevant. You can also discuss the overall findings studies on just males and just females studies.
    - What post-hoc statistical tests were used to support statement of significance in the results (ex., Females had significantly less ankle plantiflexion angle than males)?
        - Post-hoc analysis is needed to explore the differences between conditions and groups
    - What range was used for the work outcomes?
    - Bring all mean and SD outcomes into one table (easier for the reader to examine outcomes). Includes table 2, 4,6

        - The font size is small. Tables could be revised if font size can be increased, but put these revised tables beneath each other in the manuscript.
        - It would be useful to have female, male, and overall mean and SD data presented, since the focus of the paper is on gender differences
- Paper 5:
    - See Kernozek, Torry, et al (2005)
    - Various aspects of the validation steps on pages 128-129 are unclear.
        - Specifics of the subjects, data, and activity used for Anybody input should be presented.
        - This section combines methods and results. Separating these may help to solve the confusion for the reader.

Text edits

- Page 24: "This work also appraises the methodological rigor"
- Page 25: "revise "has been somehow patchy"
- FaunÃ is mispelled, check foreign language character sets.
- Page 27:
    - "side step cutting maneuvers, to name a few"
    - "view of ACL injury mechanisms"
- Page 29: "McConkey (McConkey, 1986) was the"
- Page 30: "As well, muscle activity across the ankle controls the position of the foot at landing, which most likely influence the loading at the ankle"
    - As well, muscle activity across the ankle controls the foot position at landing, which most likely influences ankle loads.
- Page 35: "Another, non contact method includes optical"
    - Rearrange paragraph to group contact and non-contact items
- Page 37: "Computational modeling has become popular partly"
- Page 37: Remove "(see for instance"
- Page 39: Reword "ACL injury research is a multidisciplinary field, since one need to consult with many disciplines in a single problem"

Content

- Page 25: "Nonetheless, the prevention of sport related noncontact ACL injuries today relies largely on the ability to screen at risk individuals and then modify through training the identified risk factor."
    - Screening for being at risk of ACL injury is not a common practice (i.e., foes not "rely largely upon)
    - Appropriate ACL at risk screening tools are not available
- Page 26: "are among the risk factors that can be modified through training"
    - Listed items are not risk factors
- Page 26: What is "hand searching", reading paper copies of journals? What journals were reviewed?
- Page 27: How did you determine that computing power was an obstacle for these studies? The choice to use slower computers does not mean that other computing options were not available.

- Page 27: What are the "the associated contributing risk factors"? What about the target activity and environment?
- Page 30: "that foot contact with the ground is an important risk factor in non-contact ACL injury"
    - o Soccer players make foot contact with the ground with each step, typically without injury, therefore this risk factor statement should be reworded
- Page 31: "ground reaction forces (GRFs) cannot be transmitted effectively through the **bones to the ground**"
    - o GRF vector is from the ground to the foot
- Page 31: "the trunk and pelvis position will have coupled effects on knee angles"
    - o The knee angle may have effect on the pelvis and trunk ...
- Page 32: "The position of the leg at the time of non-contact ACL injury displays tibial rotation, apparent knee valgus, foot pronation, and a relatively extended knee and hip
    - o You did not "display" this information in the paper. What situation is being described here? More detail is needed.
- Page 34: "These are termed contact methods and have the advantage of simultaneously including many risk factors,"
    - o How does an implanted transducer include risk factors?
    - o All relevant muscles are typically not instrumented
    - o Which forces?
- Page 36: "The major advantage of in vitro testing is its utilization of biological tissue for testing"
    - o In vitro can be defined as "In an artificial environment outside the living organism", so testing biological tissue need not be involved.
    - o Testing in-vitro is a disadvantage over in-vivo, but necessary
- Page 36: "In vitro testing also has the capability to simulate knee kinematics and muscle loads."
    - o You could also use in-vivo data to drive a simulation
- Page 36: "Other challenges with in vitro studies using cadavers are the inability to simulate realistic muscle activation and the difficulty in obtaining repeatable results"
    - o This is the same thought as the previous sentence.
    - o Repeatability is difficult in any biomechanical data collection with people
- Page 36: "Despite its shortcomings, in vitro studies have the capability to provide much freedom to investigate function and behavior of the ACL."
    - o What is meant by "freedom" in this case?
- Page 36: "From this standpoint, it can be argued that gait analysis is the only way available today to determine the kinematics and kinetics during activity to cause non-contact ACL injury."
    - o Kinematics and kinetics of what? Kinematics and kinetics of muscle-bone-ligament are typically poorly defined by gait analysis.
    - o Can whole body kinematics and kinetics (joint angles, net joint moments, etc.) truly show the cause or just a possible body position and external loading scenario for injury? Only if you actually measure an injury?
- Page 37: "A computational model of the knee joint is a graphical representation of the joint anatomy"

- A computational model does not have to be graphically represented to be used (i.e., a computational model is not a graphical representation, but can be represented graphically)
  - "A computational model is a mathematical model in computational science that requires extensive computational resources to study the behavior of a complex system by computer simulation"
- Page 38: "The main advantage of musculoskeletal RB modeling is that it enables us to determine the forces in the muscles during activities implicated to cause non-contact ACL injuries"
  - Change "determine" to "estimate"
- Page 39: "This may exacerbate itself to much uncertainty in theories used for teaching clinical biomechanics"
  - What do you mean by "This may exacerbate itself to much uncertainty"? Lack of consensus on theories? How does a lack of concensus make things worse when teaching? The instructor would present both schools of thought.
- Page 40: "reductionist approach by focusing on a single factor or few factors due to small sample size."
  - Small sample sizes are not the reason for using methods that have a small number of variables.
  - If over 250,000 ACL injures are reported each year in the USA, a reasonable sample size for a study can be achieved
  - The cost of a large study may be the real problem
- Page 40-41: Various items in this proposed methodology are difficult to achieve:
  - That "close to injury joint kinematics" were achieved
  - Accurate "tibial displacement relative to femur"
  - Accurate "muscle tendon moment arms and lengths as well as muscle forces" for people that deviate from the model
  - Since the relative tissue/bone values that are modified by the AI could be wrong but create the desired output, having equivalent net joint moments, etc. does not necessarily validate the model … it just shows that equivalent net joint outcomes could be generated.
- Page 43:
  - "Nonetheless, this approach allows for virtual experimentation which has significant implication for cost reduction through reduced equipment needs, number of subjects required for testing, and also time for testing."
    - Virtual experimentation would reduce costs if a "perfect" model was built that answered all questions. Since this is not the case, costs are still present to verify if modelled outcomes apply well in the real world.
  - "In addition, one of the central aims of this proposed approach is to provide an enabling tool to better capture the many variables, constraints, unknowns, uncertainty, and variability entailed in the complex problem of predicting injury mechanisms and identifying risk factors of non-contact ACL injury."
    - How do you capture unknowns and uncertainty?
    - It is unclear how the tools helps with this sentence
  - What do you mean by "capture the interaction"

    - "This approach should also aim to provide information that can connect the cause and effect relationships between ACL loading, injury mechanisms, and risk factors of noncontact ACL injury."
        - What information would you be providing, for example
- Page 44: The first paragraphs is confusing. After rereading this many times, the author initially states that the model should provide various outcome measures but then states that the kinematic information to create this model is not available so this cannot be achieved?
    - "One approach to resolve this challenge may be to conduct parametric and sensitivity studies"
        - Studies of what parameters?
    - An unreasonable number of studies would be required to eliminate what does not produce an injury, with the objective of only leaving conditions that cause an injury. Therefore, this is not a viable approach
- Page 46: How can AI be used to "define a problem"
    - It is unclear how data from different people, different, injuries, and different conditions can be fused to generate useful information, using the proposed input data.
- The author states an approach but has not provided a sufficient rationale as to how this can be implemented in practice.
- Page 46: "A case was not proven that "the narrow focus of some studies and the dearth of standards and specifications in the field of biomechanics appear to have the effect of limiting progress". Past study methods and standards do not limit how a research can make an advance in the ACL field. Methodological and ethical issues are more likely the limitation.
- Page 47: Creators of ACL injury prevention programmes know how their system works. There is likely not one key element, so looking for such an element may not be warranted. The holistic approaches of avoiding vulnerable positions, increasing flexibility, increasing strength, including plyometric exercises in training, and increasing proprioception should be considered.

Paper 2

Text edits

- Page 58: Revise page numbers in paper reference
- Page 70: "compare rigid and deformable contact scenarios"
- Page 71: "multivariate function that"
    - "The Levenberg-Marquardt algorithm can be thought of as a combination of steepest decent and Gauss-Newton methods."
    - "This method was modified by Fletcher (Fletcher, 1971) to tailor the amount of dampening used at each iteration so as to"
    - "Powell (Powell, 1978) to solve an over constrained system of equations via least squares optimization"
    - "The authors used an AI technique, simulated annealing, to determine"
    - "Monte Carlo simulations were"
- Page 72: "Mclean et al. (Scott et al., 2004)"

- Check reference and spelling of McLean. If reference from Scott's paper, put year of the McLean work.
- Page 75: "determine if the model can be considered valid."

Content

- Page 61: What is "combined loading"
    - "Non-contact ACL injury is also a whole body phenomenon that is best analyzed by simultaneously addressing multiple risk factors of which neuromuscular control, joint kinematics and geometry, as well as, external forces that may be the most important."
        - Are the external forces the most important or other items in the sentence? How are you proving which is the most important (include reference, ...)?
    - Video analyses are not necessarily qualitative. They may measure frequencies of injury situations, etc.
- Page 69: What is meant by "Intra subject variabilities may stem from technician performing experiments"?
- Page 70:
    - "A later study by Blankvoort et al. (Blankevoort and Huiskes, 1996) used the same mathematical model"
        - Which one, Blankevoort et al., 1991, Wismans et al., 1980?
    - "for usage in the model"
        - Which model?
    - "Blankvoort research group employed an optimization scheme to estimate the initial strains since no experimental data was available"
        - You said that the previous model was used in the last sentence?
    - I do not understand "experiments via the variation of the reference strains in the ligament". Are these other experiments on people?
- Page 72:
    - Monte Carlo methods are algorithms that randomly generate and retain the best solutions before going to the next search iteration."
        - This does not seem to be the case for Scott et al, 2008: "The Monte Carlo approach adopted within the current study necessarily considered each perturbed input parameter as independent from the next. In other words, for that N-dimensional space, we necessarily sampled input conditions from all corners of the hypercube. Adopting such an approach meant that some of the combined perturbed conditions would be highly unlikely in vivo, with performance of a successful sidestep being virtually impossible in these instances."
    - "Monte Carlo method is used primarily in this application to evaluate the probability of random outcomes of human movement."
        - This does not seem to be the case for Scott et al., 2008
    - "Monte Carlo simulation is an attractive tool since it allows researchers to study and predict risk of sustaining an injury before injury occurs."
        - This sentence is not supported by the reference

    - "However, simulated annealing is simply mentioned by the authors but the way the method is employed to answer the author's research question is not clear
        - Scott provides both the equation and reference for the simulated annealing approach
- Page 73: "whether sagittal plane knee loading during sidestep cutting could in isolation injure the ACL"
    - How is the injury isolated if the person is sidestep cutting and a load is applied?
- Page 74: "The AI technique is employed to orchestrate the fusion of the two quantitative study approaches in the MDO paradigm,"
    - What are the MDO study approaches?
- Page 74; It is unclear how clinical studies, interviews with athletes, video analyses will be used for validation
- Page 74: "An AI technique also enables one to capture the wide variability in movement patterns ..."
    - AI can also generate a wide variety of incorrect results
- Page 75: "The external forces, muscle activation, and muscle forces at this specific lower extremity kinematic should ..."
    - What do you mean by a "lower extremity kinematic"?
- Page 77: "It was shown that present challenges in non-contact ACL injury studies stem partly from the inability of existing study approaches to simultaneously capture numerous factors and parameters which are at play during ACL injury."
    - This was proposed, now shown (i.e., shown is usually associated with evidence, such as evidence that more factors and parameters improve clinical practice). Since error may increase with more parameters, we cannot assume that the final outcomes will be better for a particular method.
    - Based on this paper, the thesis should combine "biomechanical, environmental, anatomical and hormonal variables". The thesis does not include hormonal or environmental factors
    - "AI technique is better suited to address present challenges"
        - Better that OR?

Paper 3

Text edits

- Page 87:
    - "the relationship among sagittal plane body kinematics, knee power, knee work and peak GRFs."
    - "single-leg landings from platform heights of 20, 40, and 60 cm"
    - "Subjects also performed single-leg landings from a 40 cm height platform placed 30, 50 and 70 cm from the rear edge of a force plate"
    - Define first instance of VGRF, PGRF
- Page 88: "knee joint, two key factors"
- Page 90 "that hip external rotation strength had"
- Page 91: "Motion capture system (Vicon MX, Oxford Metrics, UK) consisting" to A seven camera motion capture system (Vicon MX, Oxford Metrics, UK) was used to collect ..."

- Page 92: “were instructed to stand on a variable height landing platform (20, 40, and 60 cm)”
    - o “All kinematic data and analog data were low-pass filtered using a second-order bidirectional Butterworth filter at 6 Hz and 20 Hz, respectively.”
        - This sentence could be rewritten so that the reader does not have to reread the sentence to understand, due to the use of respectively. For example, “Kinematic data were filtered using a second-order bidirectional Butterworth filter at 6Hz and analog data were filtered at 20 Hz.
- Page 93: “correlations were also used to”
    - o “finding of this study (Fig. 2) was that the horizontal”
        - No highlights/shading were show in Fig. 2.
- Page 97: “Our results corroborate these findings showing that by increasing ankle plantarflexion, there”
- Page 98: perhaps too short to allow the muscles surrounding the ankle and knee to respond.”
- Page 99:
    - o “Further, at an increasing landing height, hip and trunk flexion may be more appropriate for attenuating GRFs” both eccentric
    - o “knee power and eccentric knee work were positively and significantly correlated to both peak VGRF”

Content

- Page 87: “more appropriate for jump landings”
    - o You have shown that hip-trunk or ankle-knee strategies are used by the subjects, but not that these are the most appropriate.
- Page 90: “Although the above-mentioned studies reported valuable findings, they lack data concerning sagittal plane kinematics and kinetics of the ankle, knee, hip, and trunk at increased height and distance of landing”
    - o Combining the studies covers a range of heights and they do report flexion/extension biomechanics
- Page 91:
    - o Describe the identical shoes (brand, etc.)
    - o Define the “customized marker protocol”
- Page 93:
    - o If you are referring to the maximum VGRF, use this term instead of peak. A curve can have many peaks but only one maximum.
    - o 0.8 s before VGRF is a long time, is this correct? The entire stance phase in walking can be shorter that this time. A quick check of the literature shows 50-70 ms for time from foot strike to maximum VGRF in a jump landing and the entire event is over within 0.5 s.
    - o Using time as the basis for work calculations can create error, as opposed to event-based criteria, since timing between individuals varies
- Page 93:
    - o Did you use 2D sagittal plane kinematics or 3D flexion-extension for the analysis? I is unclear why you would take 3D data and deconstruct this to 2D

sagittal plane analysis, especially since the leg typically rotates out of the sagittal plane during landings.

- Correlations <0.7 are not high. Do you mean relatively higher that some other analysis? Typically, 0.2 to 0.4 Weak, low correlation (not very significant); 0.4 to 0.7 Moderate correlation; 0.7 to 0.9 Strong, high correlation; 0.9 to 1.0 Very strong
- "knee work as determined at the time of peak VGRF"
  - Work is typically over a range and not at a single value. How was this calculated?
- "The means and standard deviations of the sagittal plane body kinematics, knee power, and knee work"
  - Is this the mean and SD across all subjects? Please specify for text and figure captions.
- "There were no significant relationships between peak VGRF and ankle or knee flexion; however, our results indicated significant correlations between both hip and trunk flexion and peak VGRF."
  - For which tests (vertical or horizontal)?

- Pages 94, 95:
  - In methods you indicated 6 different tests, landing from 20, 40, 60 cm and landing from 30, 50, 70 cm; however, the tables on page 94 only provide one set of means. Is this the overall mean for all trials?
  - Mean and SD for all subjects need to be shown for each test condition
  - In Figures and tables, state which test conditions are being displayed in the caption. All conditions have VGRF and PGRF values so you need to specify what the reader is seeing.
  - Without the data for each trial, I cannot tell from the scatter plots how each person varies between conditions.
  - Correlation matrix is stated but only one column of data is displayed.
- Page 96:
  - "Results of this study showed that ankle and knee flexion to be moderately and significantly correlated with peak PGRF"
    - 0.395 is a weak correlation
  - "Interestingly, no significant correlation between peak PGRF and hip flexion or trunk flexion was found."
    - The weak correlations are more interesting than the significance, significance only states that the results is likely not by chance. In these cases, the correlations are low but this result may just be by chance.
  - "It was also observed that both the eccentric knee power and eccentric knee work demonstrated a moderate to high negative correlation with both the peak VGRF ($r=0.493$, $p=0.037$ and $r=0.63$, $p=0.005$, respectively) and the peak PGRF ($r=0.63$, $p=0.005$ and $r=0.475$, $p=0.105$, respectively)."
    - 0.63 is moderate, not high
    - You stated negative correlations but the r values are positive
    - It will be easier for the reader to understand this statement if they can see the results for each condition in a table

- "Results of this study (see Fig. 1 and Fig. 2) support the findings of other studies that investigated a completely different event but demonstrated a significant correlation between peak GRF and risk of knee injury"
  - This study does not make a link between peak GRF and knee injury risk, and figure 1 and 2 only show a trend between greater GRF for higher and longer jumping distances, as previously known.
- "Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings."
  - This statement is not supported. Even though the six subject's used a different strategy for dealing with landing forces, this does not mean than bending the knee cannot be used as a strategy.
- "This does not corroborate the study by Stacoff et al. (Stacoff et al., 1988) which showed that the knee joint angle can be used to reduce the magnitude of the impact loads during landing."
  - This sentence should be reworded since the results indicate that the 6 subjects did not need to increase knee flexion at maximum GRF for the test conditions, but they could have use knee flexion to reduce impact loads if required.
- "However, our study is in agreement with findings of Faugenbaum et al. (Fagenbaum and Darling, 2003) who showed that factors other than knee flexion must significantly contribute to an increased risk of noncontact ACL injuries."
  - Since this study is not testing at an ACL injury level, the study results cannot be used to make a statement on increased risk of noncontact ACL injuries.
- "Moreover, it may be inferred from our findings that the ankle may not be effective for modulating peak VGRFs at increased height of jump."
  - I need to see the results across heights to evaluate this statement
- "Our study also showed that at increasing vertical height, an increase in hip and trunk flexion can significantly reduce peak VGRF and subsequently reducing the risk of non-contact ACL injuries"
  - Your study showed that a negative correlation existed between hip and trunk flexion and jump height. Therefore, hip and trunk flexion angles were smaller at increased heights. This does not support the statement
  - Secondly, the study did not look at the effect of using more trunk and hip flexion at a higher height to reduce VGRF. You would have had to have subjects perform a series of jumps at the same high height but with progressively more hip or trunk flexion and the see the effect on VGRF.
  - Lastly, peak VGRF was not significantly reduced at the higher heights (i.e., higher height, greater VGRF)

- Page 97:
  - "Even though there are no single-leg landing studies to draw comparisons"
    - A large number of studies on single leg landing report joint angles, for many heights. These can be used for comparison.
  - "these findings are in agreement with the literature that reported that increased hip and trunk flexion may reduce the risk of non-contact ACL injuries"

- The results do not support this statement
    - "Forward trunk lean and increase hip flexion may place the body COM more anterior and could potentially decrease the contraction demand for the knee extensor muscles (i.e. quadriceps muscles), while increasing the contraction demands for the hip extensors (i.e., hamstrings muscles)"
        - You reported a significant positive correlation for knee moments and powers, so the results do not support this statement about reducing demands at the knee.
    - "at increased distance of landing, our study found that there is a statistically significant relationship between peak PGRF and ankle and knee flexion,"
        - The correlation between PGRF and angle flexion was not significant
    - "Our results corroborate these findings showing that by increasing ankle plantiflexion, there will be a reduction in peak PGRFs for landings performed at increased landing distance"
        - The results do not support this statement. PGRF is greater at longer distances. Since ankle dorsiflexion was defined as positive, the ankle was dorsiflexed at max PGRF. Also see previous statement about study methodology to verify this statement.
    - "an increase in distance of landing led to a reduction in peak PGRF"
        - The results showed an increase in maximum PGRF with increasing distance (figure 2). Values are increasing negatively, due to the force plate axis convention.
- Page 98:
    - "Perhaps the answer can be found in the time to perform such tasks. For increasing landing heights the time to perform the single-leg landing is very short, perhaps to short to allow the muscles surrounding the ankle and knee to respond."
        - No timing results were presented to support this statement. These results must be included in the paper. How much less time with increasing height? How does this difference relate to motor control times?
        - Which time are you referring to, from airborne to landing, from ground contact to maximum force?
        - Without evidence, this statement should be removed.
    - "Future studies by the authors will endeavor to employ a larger sample size as well as to account for the effect of gender during single-leg landing from varying heights and distances."
        - This sentence is typically in the conclusions
    - "The landing strategy recommended here and discussions stemming from this study"
        - A landing strategy was not recommended in the paper
        - No discussions from this study were reported
    - "Further in vivo and in vitro studies using a large and varied subject population, as well as computer simulation studies are needed to solidly validate our findings, and determine whether the landing strategy found actually reduces ACL loading in vivo."

- This sentence can be removed since it is not related to the study (i.e., no ACL-injury inducing findings were reported in the study that would need to be validated)
  - "This study investigated the relationships between varying vertical height, horizontal distance, and peak GRFs during single-leg landing and further related these findings to risk of non-contact ACL injury"
    - The study results were not successfully related to ACL injury
- Page 99:
  - "Further, at increase height of landing, hip and trunk flexion may be more appropriate for attenuating GRFs"
    - This statement is not supported by the results
    - More appropriate that what other strategy?
  - "while at increase distance of landing, ankle and knee flexion may have more potential to attenuate GRFs"
    - This statement is not supported by the results
    - More potential that what other strategy?
  - "Hence, the biomechanical strategies for decelerating the body in the vertical and horizontal directions may be different."
    - You can make a stronger statement since, for your subjects, there was a clear difference between vertical and horizontal landing strategies
  - "In addition, both eccentric knee power and eccentric knee work was positively and significantly correlated to both peak VGRF and peak PGRF"
    - PGRF knee work was not significantly correlated

Paper 4

Text edits

- Page 104: "explain the higher number of injuries among females"
- Page 106: "To undertake this, a relationship between three non-contact ACL injury risk predictor variables (maximum VGRF, maximum PGRF, maximum knee abduction moment) and selected single-leg landing biomechanical variables were studied"
- Page 107: "The seven camera motion capture system (Vicon MX, Oxford Metrics, UK) collected marker trajectories at a sampling rate of 250 Hz."
- Page 111:
  - "$F(1,9)=20.91$, $p<0.01$, partial η $2=0.699$ with ankle plantarflexion angles."
  - "More specifically, there was a significant height×distance interaction Greenhouse-Geisser adjusted"
  - "interaction Greenhouse-Geisser adjusted $F(3.31, 29.79) =3.73$, $p=0.019$; partial η $2=0.293$ for peak VGRF, $F(2.17, 19.54) =4.13$, $p=0.029$; partial η $2=0.315$ for knee internal rotational moment, $F(2.58, 112\ 23.22)=3.15$, $p=0.05$, η $2=0.26$ for hip flexion, and $F(2.98, 26.79)=3.90$, $p=0.02$, η $2=0.30$ for trunk flexion."
    - This sentence is difficult to read. Please revise.

Content

- Page 104:

- "The number of non-contact ACL injuries is higher among females; however, there is no conclusive evidence that this is due to biomechanical differences between genders. One explanation is the lack of studies investigating gender differences in whole body biomechanics during single-leg landings from increasing vertical heights and horizontal distances."
    - The evidence is strong that males and females have biomechanical differences for the target activity related to landing (many studies, some with large samples). The statement should be revised
- "reaction force (PGRF) for males (r=–0.85, p=0.004),"
    - Assuming that the 6 males are the same people as in paper 4, why is the r value different?

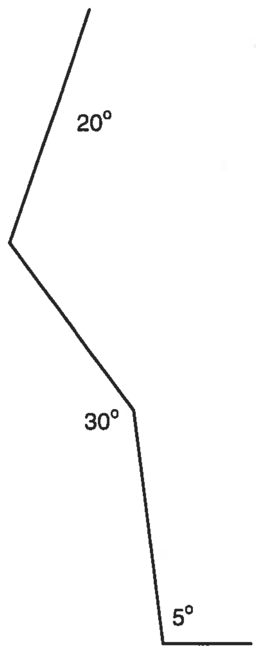
- Page 105:
  - "while nearly significant and moderately correlated to peak PGRF for females (r=–0.542, p=0.13)"
    - 0.13 is not nearly significant at the p<0.05 level
  - "while no significant interaction was observed for distance and gender"
    - Why would you anticipate an effect for distance and gender? Both gender group performed the same methods and therefore move the same distance.
  - What are "ankle plantiflexion angle gender effects"
  - "There are few single-leg landing studies in the literature"
    - Many single-leg landing studies are in the literature, I made a quick search and found over 16 studies so far in 2011. The review paper by Schmitz, 2007 has 34 references just on the topic of gender differences
  - "Further, most single-leg landing studies only report data on the knee joint kinematics and kinetics."
    - A sufficient number of studies report results for other joint, therefore this sentence should be revised
  - "Hence, peak PGRF may also predict the risk of sustaining a non-contact ACL injury"
    - Alternatively, it may be the increased in resultant force that is the issue and not an isolated increased in the PGRF vector. Greater VGRF also causes an increase in eccentric knee extensor moments.
- Page 107:
  - Please make same changes to Procedures as outlined in the Paper 3 comments
- Page 109:
  - "ACL injury risk predictor variables and various selected dependent variables"
    - Please list the variables
  - "current study did not produce the characteristics distinct biomodal GRFscurve commonly reported during double-leg landing (Dufek and Bates, 1990; Zhang et al., 2000)"
    - The GRF curves were consistent with single leg landing curves form the literature. The sentence should be revised to compare with single leg landing and not double leg landing, since this is a single leg landing study.
    - This sentence should also be moved to the discussion since a literature comparison is not needed in the results.

- "The demands of the current tasks studied resulted in a smoother increase to GRF"
  - Smoother than what?
- "Therefore, the biomechanical comparisons of double leg landing with single leg landing results in the literature may be limited due to the differences exhibited by the two tasks."
  - Comparing single and double leg landing is not the focus of this paper, so these sentences should be removed.

- Page 111:
  - "Follow up tests with the three non-contact ACL injury risk predictor variables"
    - No follow-up tests were described in the methods
  - "Females had significantly less ankle plantiflexion angle than males"
    - What stats were used for this result?
  - "while a moderate but near significant negative correlation for females ($r=-0.542$, $p=0.131$)"
    - 0.131 is not near significant at the $p<0.05$ level
- Page 112:
  - Table 2 must provide mean and SD for all outcomes discussed in the results and discussion.
- Pages 113-114:
  - Table 2: The results for males are strange since the ankle is more plantarflexed as the height increases but dorsiflexed (or less plantarflexed) at the longer horizontal distances. This typically means that the tibia is behind the ankle when the foot is flat (assuming maximum VGRF does not occur until the heel contacts the ground). Since the knee is approx. 28-32 degrees flexed and trunk is 17-21 deg flexed, this puts the body in a strange position (see below). The dorsiflexed ankle angle for the women seems more understandable.
    - As in the figure below, cofg would be behind the base of support and without arm motion recovery of balance would be difficult
    - Since the SD for ankle angles are quite high (1-5x higher than the mean) does outlier data account for these differences?
    - This should be discussed
  - Table 3: Why are the correlations for males greater than in paper 3?
    - Are all trials across all conditions used for these correlations?
  - Table 5: Are these correlations for all conditions and all subjects?
  - Data are duplicated in tables 5 and 7
- Page 115:
  - See ankle angle comments above
  - "Our results revealed that females exhibited significantly lower ankle plantiflexion"
    - Females are dorsiflexed (Table 2)
  - "which offers a possible explanation to the higher number of non-contact ACL injuries among females,"
    - Since you are analyzing the ankle angle at maximum VGRF, this point does not relate to the mentioned studies, which are considering ankle angle at initial contact

- "Hence, a reduction in peak PGRF may be realized by increasing ankle plantiflexion during single-leg landing which subsequently may reduce the risk of non-contact ACL injury"
    - PGRF did not decrease as distance increased, so this point is not supported.
- "Perhaps an increase in plantiflexion permits more time to distribute the impact forces and better enables the musculature to absorb these forces as demonstrated by the following studies"
    - This study only looked at the maximum VGRF instance in time so this statement is not supported by the study.
- "and implies that horizontal distance of landing—often ignored in most studies—is an important variable"
    - This force component is not ignored, please rephrase
    - Importance for what? ACL indicator? I would expect that the resultant force is the main item, with this force being larger if the person jumps farther (higher, longer, or longer and higher)
- "Our results also suggest that knee abduction moment can be modulated by increasing trunk flexion"
    - This statement how you arrived at this statement. Please expand on this and support with the project outcomes.
- "Given there are no single-leg landing studies to draw comparisons"
    - Many single leg landing studies exist for comparison. Please use these.
- "Perusal of the main effects of height and distance correlated with selected biomechanical variables (see table 7) revealed that increased knee flexion angle, hip abduction angle, knee power, knee work and horizontal distance between foot and the body COM, as well as, an accompanying decrease in vertical distance between foot and the body COM, is associated with reduction in peak VGRF, thereby demonstrating the possibility of these variables to reduce the risk of non-contact ACL injury.
    - This statement has many problems.
    - VGRF increased (i.e., not reduced)
    - Variables increased as VGRF increased, so how can you prove that these variables reduced risk (i.e., variables increased but VGRF still increased)
- "Without studies to draw comparisons"
    - Other single landing studies exists that can be used for comparison
- "In addition, our results revealed that at increased in plantiflexion angle, knee flexion angle, knee power, knee work, and horizontal distance between foot and the body COM, as well as, an accompanying decrease in vertical distance between foot and the body COM is associated with a reduction in peak PGRF.
    - Same issues as with VGRF
    - PGRF either increased with greater horizontal distances or was almost unchanged (h60d30,h56d50)
- "knee abduction moment and the biomechanical variables tested suggesting that knee abduction moment may be less a predictor of risk of non-contact ACL injury compared to peak VGRF and peak PGRF for single-leg landing tasks."

    - This may be due to the female subject sample for the study. Did the subjects have moderate-large q-angles?
    - If the subjects did not land in an abnormal knee abducted position, then you cannot test to see if knee abduction moment is a good indicator since the moments would be larger if the person lands with more knee abduction.
    - Your subjects may have been sagittal plane dominant but some people have larger frontal plane deviations (see literature on females landing)
- "Our findings (see table 7) reveal a significant and high positive correlation between both peak VGRF and peak PGRF, and the vertical distance between the foot and body COM supporting the findings in the literature …"
    - The COM results are for vertical COM distance should be discounted since this distance only changed by 3 cm (96-99 cm) and this difference is within the error of identifying COM. Therefore, the data shows that vertical COM could have no real-world effect, even through there was a correlation.
    - Also, you did not measure the range of COM motion so the study cannot show if COM was lowered.
- "Due to the lack of studies examining body kinematics and kinetics over increasing heights and distances, we are unable to fully compare our results with the literature."
    - If you make a table with the results from the literature, you will have information for many variables over a range of heights and distances, for many subjects.
- "relatively small sample size (N=11),"
    - Comparison size is even smaller (n=5 for females)
- "The landing strategy recommended and discussions stemming from this study"
    - See paper 3
- "Lower plantiflexion angles was observed for females"
    - Females were dorsiflexed, which will allow the ankle to progress forward to attenuate forces. The problem would be if they landed with 0 degrees and no movement occurred.



Paper 5

Text edits

- Page 122: "While contributing to an understanding"
- Page 128:
  - "uses the anthropometric data measured for each subject to scale the MSM (Rasmussen, 2005). An optimization-based method …"
  - "taken, firstly, we compared"
  - "This information is presented in an on-off timing curve (Fig. 2) that shows when the measured and predicted muscles activity goes above (turns on) and below (turns off) a 20% threshold during single-leg landing. Secondly, …"
- Page 129: "using the subject-specific MSM, example provided in Fig. 3, after completing"
- Page 131: "Separate 3×3 two-within-one-between subject repeated measures ANOVAs were conducted"

Content

- Page 122:
  - "Results revealed no significant gender differences in the musculoskeletal variables tested except peak VGRF (p=0.039), as well as, knee and hip axial compressive force (p=0.05, and p=0.032, respectively)."
    - In paper 4 no significant difference was found for VGRF but the 3 subjects that were selected for paper 5 show a significant difference. Therefore, the selection of these 6 subjects is questionable.

        - Since axial load is related to VGRF, these significant differences could also be attributed to subject selection from your population sample.
    - "Our results showed no significant association between quadriceps force and risk of ACL injury"
        - This makes sense since you did not have injury inducing loads during testing
    - "Within the limitations of the subject-specific MSMs, our findings indicate that musculoskeletal variables studied are not the sole determinants to ACL injury."
        - It is difficult to make a statement on ACL injury based on the methodology
- Page 124:
    - Check references for Shin (2007,2009, 2011), Mokhjtarzadeh, Yeow, et al. (2010), Bulluck (2010 – Masters Thesis) for models and single leg landing
        - Since loads at 60 cm are non-injury inducing but higher than the lower heights, are the lower height trials necessary if the focus is on ACL injury?
        - Bulluck performed a similar study so his results should be used in the comparison. Especially since quadriceps and hamstring results were different.
    - "The ability of body kinematics or lower extremity muscles to attenuate the GRFs upon landing from a single-leg requires further investigation."
        - This broad statement is not supported. Many studies exist in the literature, what aspect of force attenuation is lacking?
    - What do you mean by "elaborate internal joint loads"?
- Page 125:
    - Weight and height matching of the males and female populations does not necessarily improve the methods since females are typically shorter and lighter than males.
    - What shoes were worn (brand, etc.)
- Page 128:
    - Define AMS
    - IDA is not used later in the text so this abbreviation can be removed
    - "Secondly, the joint forces and moments measured in vivo at the knee joint during gait and reported in the literature were compared with predicted knee joint forces and moments"
        - Include reference to this gait literature. Was this walking gait? Both males and females?
        - This paragraph can be rewritten to more clearly show the methods. For example,
            - "Secondly, the joint forces and moments measured in vivo at the knee joint during gait and reported in the literature were compared with predicted knee joint forces and moments (Table 1). The MSMs were driven with the individual subject's knee joint forces and moments obtained from single leg drop landing trials.
    - "Based on these findings and recognizing variability in body anthropometry between studies, it appears that the developed subject-specific MSMs tends to

reproduce the trends in internal forces and moments well while systematically overestimating the joint reaction forces."

- Which findings? The literature review?
- No trend for most measures in table 1 (i.e., only one comparison value)
- Anybody results are higher than the range for Fz and Fx only, therefore they do not reproduce the trends and did not show a systematic overestimation (Fy was not higher)
- What are the Anybody results? Mean of all 6 subjects?

- "The latter can be controlled in the MSMs by adjustment of muscle moment arms, but in the interest of reproducibility it was elected to not pursue this option."
  - What is "the latter"?
  - So what was done to correct the models? Was the error left in place?

- Page 128:
  - "The time at which peak VGRF occurred was used to determine the selected musculoskeletal variables."
    - This sentence indicates that the VGRF time in seconds was used to select the variables used in the analysis. Since this is probably not the case, please revise.
- Page 130:
  - Figure 2:
    - The activity and start-end events are unclear.
    - Including event timing in the figure would help the reader (foot strike, etc.).
- Page 132:
  - "Nonetheless, the trends in the predicted muscle activations (thin lines) sets in reasonably close in time as the measured muscle activations (fat lines), therefore demonstrating fairly good agreement between model prediction and experimental data"
    - What do you mean be trends?
    - The comments of "reasonably close" and fairly good" do not support the use of the defined model for further study. Tibialis anterior and rectus femoris are quite different and the timing/duration factors could adversely affect the model's ability to predict forces.
  - It is not clear where Figure 3 shows the interaction with the environment
- Page 133:
  - Figure 3: It is questionable to state that the model has been validated due to the errors.
  - A table of means and SD for main measures is required (maximum VGRF, Hip & Knee axial forces, max PGRF, max Proximal tibial shear force, etc.), with male and female results separated.
    - Later in the document, Table 3 provided some data, but only for the entire sample. The male and female results are needed separately since this is the analysis that is presented.
  - "Between genders, females had significantly lower peak VGRF, as well as, knee and hip axial compressive forces."
    - What statistic was used for this posthoc analysis?

-
- Page 134:
    - Figure 4
        - Revised to only show the data from foot strike onwards (inactivity from 8-85% is not needed for these graphs).
        - Y-axis scaling should be the same for males and females
        - In a printed version, I cannot distinguish the curves by the legend. PDF enlargement to 300% was sufficient.
- Page 135:
    - "From descriptive statistics –not presented– one can observe an almost linear increase"
        - Since these statistics were not presented, I cannot observe this increase.
    - "Follow up test with this variable and the two non-contact ACL injury risk predictor variables revealed no significant correlation."
        - What was this followup-test. Please provide the methods and results or remove from the paper.
    - Is height the jump height or the subject's height?
    - "Results revealed no significant height×gender, height×distance or height×distance×gender interactions (Table 1).
        - Table number is incorrect in paragraph
- Page 137
    - Figure 5: The y-axis label is muscle force; however, the EMG data was not scaled to force but to a % of maximum voltage. How did these data become converted to BW?
- Page 138:
    - "This study showed that single-leg landings did not produce the characteristic bimodal VGRF curve commonly reported for double-leg landings"
        - Yeow (2010) had similar shaped curves in his study that tested both single and double leg landing.
        - The reason could be that you did not allow arm movement on landing. Therefore you are correct that the difference was related to the task but it should be mentioned that you are dealing with a "single leg landing without arm movement" and not a typical single leg landing.
    - "This finding is important as it elucidates the unique nature of single-leg landing studies whose findings cannot be compared with double-leg landing studies"
        - Revise as per previous comment
    - "Females may have experienced lower VGRF upon single-leg landing because of their lower quadriceps to hamstring muscle activity resulting in higher energy absorption and subsequently lower VGRF."
        - You cannot determine energy absorption since the analysis was at one point in time (VGRF). To make a conclusion, you should reanalyze the data and see if the females have greater energy absorption over the entire limb loading task.
    - "Existing single-leg landing studies in the literature … do not include the effect of the muscles"

        - See Shin (2007,2009, 2011), Mokhjtarzadeh, Yeow, et al. (2010), Bulluck (2010 – Masters Thesis)
    - "Our findings support this argument showing no significant association between quadriceps muscle force and the two possible non-contact ACL injury risk predictor variables."
        - It is difficult to say that the results from this study contribute to the ACK injury risk factor discussion since the subjects were not in an injury situation
    - "Our results also corroborate other studies (Pandy and Shelburne, 1997; Yu and Garrett, 2005) that found hamstring muscles did not reduce ACL loading when knee flexion angles are small."
        - An analysis of hamstring muscles and knee angles was not presented in the results.
    - "Our results showed that increasing gastrocnemius muscle force protects the ACL by reducing both peak VGRF and peak PTASF (Table 3b)."
        - Table 3b shows a negative correlation, so gastrocnemius muscle force decreased as the VGRF increased. This does not prove that the gastrocnemius protects the ACL.
    - "Even though the predicted absolute values of muscle activations as well as knee joint forces and moments are overestimated, the trend agreement between …"
        - No trend data were provided that proves this statement
    - "Given the number of variables that can affect the ACL loads in vivo, our findings suggest that musculoskeletal variables are only one facet to non-contact ACL injury biomechanics, and factors such as hormones, strength training, fatigue or a combination of all these, may perhaps better explain the gender disparity in the incidences of non-contact ACL injury."
        - It is unclear how the study methods and results support this statement.

Discussion

- Page 146: "To address this concern, the authors presented a novel study approach that — once developed— can enable researchers to capture many of the parameters and extreme conditions simultaneously involved during non-contact ACL injuries"
    - Interestingly, the recommended method from the first two papers was not followed in this thesis.
    - Since the MDO method was not used in this thesis, does this show that the MDO method would be nice but may not be practically to implement.
- Page 149:
    - "Since there were no studies investigating body kinematics and kinetics during single-leg landing from increasing vertical heights and horizontal distance"
        - Studies exist for increasing heights, but not horizontal distance
    - "Investigations of how the body kinematics can attenuate these applied forces may provide insights into the ability of the body to reduce the loading seen at the ACL"
        - The studies did not look at how forces are attenuated (i.e., analysis was performed at maximum GRF)

    - “Furthermore, at increase height of landing, hip and trunk flexion may be more appropriate for attenuating peak VGRFs, while at increase distance of landing, ankle and knee flexion may have more potential to attenuate peak PGRFs “
        - Use of arms should also be considered (i.e., does lack of arm motion affect trunk position (balance, etc.)?)
    - “This does not corroborate the study by Stacoff and co-workers (Stacoff et al., 1988) that showed that the knee joint angle could be used to reduce the magnitude of the impact loads during landings.”
        - Less knee flexion from the study sample does not mean that the Stacoff results were incorrect, just that some other method was used. This statement should be reworded.
- Please see previous comments on each paper for revisions to this section

Conclusions
- Comments in this thesis review should be considered when revising the conclusions.

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FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

THESIS EXAMINER'S REPORT

uOttawa

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Canada's university

NAME OF STUDENT Nicholas Ali	STUDENT NUMBER 5033260	DOCTORAL THESIS ☒	MASTER'S THESIS ☐
DEGREE Ph. D.	ACADEMIC UNIT School of Human Kinetics		
TITLE OF THESIS "Predicting Risk Factors of Non-Contact Anterior Cruciate Ligament Injuries During Single-Leg Landing"			
NAME OF THESIS SUPERVISOR Dr. Gordon Robertson	NAME OF THESIS CO-SUPERVISOR Dr. Gholamreza Rouhi		
NAME OF EXAMINER Dr. Michel Labrosse	DEADLINE FOR SUBMISSION OF REPORT December 19, 2011		

PART A: EVALUATION / Tick off the choice that best describes your evaluation of the thesis.
PART B: COMMENTS / Provide your comments for each of the topics listed.
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→ RESEARCH METHODOLOGY
→ ANALYSIS OF RESULTS AND VALUE OF CONCLUSIONS
→ ORGANIZATION, WRITING STYLE AND PRESENTATION OF MATERIAL
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Do you recommend this thesis for a prize?

☐ YES – Please complete the attached NOMINATION FOR THESIS PRIZE form.
☑ NO

The absence of a reply will be considered a NO.

DATE Dec 7, 2011 SIGNATURE Michel Labrosse

Please return all documents by email to fssrecherche@uOttawa.ca or by fax to 613-562-5437 and send the originals in the enclosed self-addressed envelope to:

Assistant to the Vice-Dean, Research & Graduate Studies
Faculty of Health Sciences
Roger Guindon Hall
451, Smyth Road Room 3028
Ottawa ON K1H 8M5

Dr. Michel Nadkosoc

Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing

Understanding of the subject matter

The candidate shows a thorough understanding of the literature as well as the experimental and simulation aspects related to non-contact ACL injuries.

Contribution of the thesis to advancing knowledge

The candidate's main contribution is to show unambiguously, based on an extensive literature review, that non-contact ACL injuries are multifactorial, not just with regards to biomechanics, but also anatomy, physiology and training. The candidate then goes on to propose a potentially all-encompassing approach to better understand the mechanisms leading to injuries, so as to come up with better training regimens to avoid them. The candidate pieces together a big picture based on current technologies and methods; however, the proposed approach is extremely computer intensive and no attempt is made to demonstrate its feasibility in reasonable computational times. The candidates then sets out to look at non-contact ACL injuries at a much smaller scale of complexity while still considering several factors simultaneously (even those often unaccounted for in other studies, such as trunk motion). Specifically, the candidate experimentally investigates body kinematics and dynamics during single-leg landing from various heights and distances. This in itself constitutes another new and valuable contribution. The candidate then applies computational simulation methods to determine the major muscle loads, again another valuable contribution. Overall, the topic of non-contact ACL injuries benefits from the work done by the candidate, although it is clear that a quantitative, validated unifying injury scenario still remains to be proposed.

Research methodology

The research methodology used by the candidate combines extensive use of the literature, as well as experimental and computational simulation means. It is adequate and corresponds to the expectations of a doctoral thesis. While the sample size for the experiments is small, the results achieve statistical significance (for the population segment tested) and perhaps more importantly, partially illustrate the multifactorial analytical approach proposed by the candidate.

Analysis of results and value of conclusions

The results are mostly properly described and analyzed throughout the dissertation. Clearly, the most interesting material with regards to analysis of experimental data is contained in Papers IV and V. However, there is some discontinuity in the results shown in both papers, although these results were assumedly obtained from the same set of experiments. This will deserve explanations during the oral defense and will likely justify revisions of the dissertation.

Organization, writing style and presentation of material

The organization and writing style of the material are acceptable, but would benefit from serious polishing and rewording/shortening of many unduly long and complex sentences. Many typos were also spotted. Many figures, graphs and tables are too small or too crowded, a problem that needs to be addressed.

Revisions considered necessary in order for the thesis to be accepted

See sections above. Revisions related to these issues are strongly recommended, but do not affect the acceptance of the thesis.

General comments

The candidate addressed a rich and complex topic, and put together a study representing a reasonable amount of work. Paper IV essentially repeats Paper III and goes further. Therefore, one should consider the deletion of Paper III for conciseness. A synthetic view of the non-contact ACL injury mechanism is still to be proposed, but the candidate has made interesting strides toward this goal.

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PART C: RECOMMENDATION FOR A PRIZE

Do you recommend this thesis for a prize?

☐ YES – Please complete the attached NOMINATION FOR THESIS PRIZE form.
☒ NO

The absence of a reply will be considered a NO.

PART D: SIGNATURE

DATE Dec/6, 2011 SIGNATURE [signature]

PART E: DOCUMENTS

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Assistant to the Vice-Dean, Research & Graduate Studies
Faculty of Health Sciences
Roger Guindon Hall
451, Smyth Road Room 3028
Ottawa ON K1H 8M5

Dr. Daniel Benoit

Evaluation report summary for Nicholas Ali.

This thesis fails to meet the standards for a Ph.D. degree for a number of reasons, including but not limited to :

1. The thesis does not constitute a significant contribution to knowledge and the analysis by the student is not of such quality as to merit publication.
    - Note: although 2 literature reviews are published, neither is in a journal particularly related to the subject matter presented. Neither describes the methodology used to decide on the chosen articles. Neither uses any criterion to evaluate the included articles. As reviews of literature, they are not significant contributions.
    - I would not consider the final three manuscripts (III, IV and V) merit publication due to, among other things described further on, methodological concerns such as a lack of sufficient subjects (manuscripts III, IV, V). Paper V also lacks model validation (although it is stated many times in the thesis that this has been done) and uses a male musculoskeletal model to represent females (it is simply a scaled down size of model, as pointed out to me by the co-authors on the paper). To my knowledge, this paper has also been rejected outright by the journal it was submitted to, although it is still referred to as submitted in the thesis.

2. The work was not done in accordance with established methodology employed by the discipline. (below is a non-exhaustive overview of some of my concerns)
    - Results of the experimental manuscripts are inconclusive and not valid due to lack of sufficient subjects in all three manuscripts. No power analysis was reported but, based on my experience in the discipline, at least 2 to 3 times the number of subjects are required in manuscripts III and IV, likely more would be required for paper V.
    - The paper V purports to evaluate gender differences using musculoskeletal models, however (for example), only three subjects of each gender are evaluated and the model used on both genders is in fact a male model…in other words, the females are in fact treated as height and weight adjusted males. The claim in the manuscript that the model has been validated is not supported by the results.
    - Although the use of a repeated measures ANOVA is questionable in all three experimental manuscripts due to the number of subjects evaluated, it is particularly dubious in paper V where only three subjects are in each group, not to mention that no correction for related measures is considered, nor is the post-hoc analysis described.

- The external validity of manuscripts III and IV is limited, as stated by the authors themselves.
- The internal and external validity of paper V are limited.

3. <u>The thesis does not exhibit the candidate's capacity to meet the scholarly standards required. (below is a non-exhaustive overview of some of my concerns)</u>
    - The methodological concerns noted above indicate that the candidate lacks the scholarly standards from a technical (methodological) point of view.
    - Information contained in the thesis is misleading since at least two of the declared conference presentations were never presented.
    - Letters from the editors of the journals with manuscripts Under Review are not provided. This is an essential first step since, to my knowledge, at least one of those manuscripts has in fact been rejected outright and this is not noted in the thesis.
    - The two accepted manuscripts are reviews of literature in journals that are not reflective of the article content and, although accepted, are of limited value due to a less than rigorous or exhaustive methodology which is not coherent with systematic reviews.
    - Manuscripts IV-V lack statistical power, adequate methodological descriptions, and inappropriate use of statistical measures.
    - The student repeatedly states in the thesis that a lack of multifactoral research exists in the study of ACL injuries yet many of the studies sited are multifactoral in their approaches, in particular those that combine kinematics and kinetics or musculoskeletal models… the student seems to dismiss these in order to justify this thesis, instead of acknowledging what has been done and how it contributes to the field of study and does not seem objective. Then, in the end, the study uses similar methodologies to form his conclusions as the papers previously criticised

4. <u>Even with extensive revision, the thesis would not meet the standards required for the degree.</u>
    - As a body of work there are too few subjects, weak methodological and statistical approaches and overreaching conclusions beyond the evidence suggested by the results in all three experimental papers.
    - The two published manuscripts are of limited contribution and published in journals which are not discipline-related.

5. UNDERSTANDING OF THE SUBJECT MATTER

The candidate states:

"*To the best of the author's knowledge no study to date has investigated gender differences during single-leg landing from increasing vertical landing heights and horizontal landing distances.*" Meanwhile, there exists a great body of knowledge about the biomechanics and associated risk factors of single leg landing under various experimental and simulated conditions, including vertical landing heights, for example.

"*Further, there are no MSMs in the scholarly literature that has been developed, validated and applied to single-leg landing in the literature.*" Untrue, there are… not to mention that the student does not fill this purported void with the thesis.

"*Further, the majority of studies in the literature pertaining to single-leg landing do not account for the effects of whole body movement on ACL loading.*" Untrue, there are… not to mention that the student does not fill this purported void with the thesis.

"*In addition, to the author's best knowledge, the current literature demonstrates that there are no proposed multifactorial study approaches aimed at fusing existing non-contact ACL injury study approaches into a single environment using an AI technique.*" This statement is unclear since it is unclear what the author is referring to as an AI environment. Two thing are certain: (1) many studies have used multifactorial models and approaches to investigate non-contact ACL injuries; (2) if the candidate refers to the approach he has taken in Paper-V, then it is again untrue and others have done this before, whereas if he is referring to some new innovative approach, the candidate has not done it in this body of work nor elucidated what that approach would be.

"*These models are driven by kinematics and external forces.*" The candidate is speaking of musculoskeletal models but fails to recognise the body of literature which uses EMG driven models, which are in fact driven by internal forces, as muscles are internal force generators to the system.

6. CONTRIBUTION OF THE THESIS TO ADVANCING KNOWLEDGE

Very limited since the validity of the studies (both internal and external) is questionable. In particular, a lack of subjects make the results highly speculative and the statistical approaches inappropriate. There is little innovation aside from modifying jump height and distance, and the two reviews of literature are not exhaustive or systematic and seem biased.

It must also be stated here that paper V uses a commercially available software (ANYBODY) to build the model and analyse the data, not a custom model developed by the student. This is not clear in the thesis.

7. <u>RESEARCH METHODOLOGY (this is a non-exhaustive summary)</u>

Paper I:

- The methodology described for the initial review of the literature seems initially exhaustive, however when I used one of the 4 search terms provided by the authors I turned up 3743 articles whereas the authors found 813 articles total; furthermore no criterion for triage down to the 147 articles cited is given by the authors. Considering the strong focus on modeling in the paper, at least one search term should include the word model or simulation, for example.
- One example of a lack of depth to the discussion: "*Mathematical programming and the Monte Carlo method (Blankevoort and Huiskes, 1996; McLean et al., 2003) are the current often used optimization approaches employed to study ACL mechanics. Although both mathematical programming and Monte Carlo methods have demonstrated their usefulness and effectiveness as a research tool, there are much more advanced and robust AI techniques; namely, taboo search, simulated annealing, genetic algorithms, and artificial neural networks.*" In fact, "simulated annealing" is currently one of the most popular and widespread methods in musculoskeletal modeling...

Paper II:

- It is not quite clear if this paper is a review of literature or opinion-piece on how to investigate ACL injury. To me, it is more of an opinion piece and is more suited to be in a thesis discussion then as a publication since it lacks objectivity.
- It is not clear why the authors would chose this journal as it does not seem to be related to the field being investigated.
- Similar concerns with regards to the approach and criterion used to select papers as paper 1 above.
- This paper would serve as an introduction to the thesis, but in my opinion is not an in depth review.

Note that while I believe it is a good idea to try and publish one's thesis, papers one and two seem to be the review of literature portion of the thesis as opposed to original scientific contributions to the literature.

Manuscripts III and IV:

- The purpose of these manuscripts is good.
- The actual measurement techniques (i.e.: in laboratory techniques) in these manuscripts are acceptable.
- There is a lack of subjects, putting the statistical analysis and validity in doubt. I believe that this statement by the authors is worth noting: "*this study is limited by a*

small sample size; hence our results may not be representative of the general population and may not be conclusive. While we cannot conclude the general male population would exhibit sagittal plane body kinematics, knee power, and knee work as determine in our study for single-leg landings, we were able to show that the relationships found have a good fit in terms of r2 and p values for the six subjects tested." The r-square and p values are questionable since there were not enough subjects to perform these tests in the first place…as a PhD thesis, this is unacceptable. These two manuscripts are better described as pilot projects or incomplete projects.

- Even if one considers the correlation values reported, the relatively low levels of correlation make conclusions difficult to support (a statistically significant correlation does not necessarily mean an important one…)
- The emphasis in the two reviews of literature is to avoid a reductionist approach when studying the ACL injury, yet these manuscripts do exactly that.
- It is unclear if the subjects from paper III were used in paper IV and this should be stated.
- A table containing the dependant variables for each independent variable would be beneficial.
- The choice of dependant variables is not clear "*various selected dependant variables*" is the only information given.
- No consideration of the inter-dependence of the selected variables is given and no correction of the probability coefficient is considered for these variables
- Given paper IV, paper III seems redundant.

Manuscript V:

- Too few subjects (3 males and 3 females) to extract meaningful conclusions. Similar to manuscripts III and IV, this manuscript is a good beginning, but not and end product.
- There is a lack of model validation: the authors somehow conclude that the musculoskeletal model is valid based on EMG activations which are not reflective of the predicted model-driven activations, with no objective comparisons…this makes no sense to me.
- The model used in this paper is not novel nor is it developed by the candidate: it is an application of a musculoskeletal model from the ANYBODY Software repertoire, which requires the user of that model to adjust the model to the input data.
- The model used for the female subjects is a scaled version of the male model, not a gender-specific model. As such, it cannot take into account physiological and anatomical differences between the sexes, even though the purpose of the paper is to evaluate these things.

8. ANALYSIS OF RESULTS AND VALUE OF CONCLUSIONS

- The statistical analysis of the results is questionable due to the small sample sizes in all manuscripts
- The validity of the model used in paper V is not established; the use of a male musculoskeletal model to represent females is questionable, in particular given the anatomical and neuromuscular sex-related differences highlighted by the candidate, for example
- The value of the conclusions was accurately put into doubt by the candidates own statements regarding a lack of sample size for manuscripts III and IV.
- The value of the conclusions for paper V are in doubt due to a lack of sample size and the above mentioned lack of model validation and use of a male model to represent females.

9. ORGANIZATION, WRITING STYLE AND PRESENTATION OF MATERIAL

- The organization of the manuscripts is very good.
- The writing style is good.
- Presentation of the material is good.

10. GENERAL COMMENTS

In its present form, this body of work does not represent a Ph.D. thesis. Paper status and conference presentations must also be clarified by the candidate.

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NAME OF THESIS SUPERVISOR Dr. Gordon Robertson		NAME OF THESIS CO-SUPERVISOR Dr. Gholamreza Rouhi	
NAME OF EXAMINER Dr. Graham E. Caldwell		DEADLINE FOR SUBMISSION OF REPORT December 19, 2011	

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→ GENERAL COMMENTS

Your comments and explanations are extremely important and will:

- help the student prepare for the defence or make necessary revisions to the thesis (if revisions are required before the defence, a signed copy of your comments is provided to the candidate, the thesis supervisor, as well as to all members of the jury and the chair of the academic unit);
- allow the dean of FGPS to make an informed decision if the jury is divided; and
- allow the FGPS selection committee to choose recipients of prizes and medals.

PART C: RECOMMENDATION FOR A PRIZE

Do you recommend this thesis for a prize?

☐ YES – Please complete the attached NOMINATION FOR THESIS PRIZE form.
☒ NO

The absence of a reply will be considered a NO.

PART D: SIGNATURE

DATE December 18, 2011 SIGNATURE Graham Caldwell

PART E: DOCUMENTS

Please return all documents by email to fssrecherche@uOttawa.ca or by fax to 613-562-5437 and send the originals in the enclosed self-addressed envelope to:

Assistant to the Vice-Dean, Research & Graduate Studies
Faculty of Health Sciences
Roger Guindon Hall
451, Smyth Road Room 3028
Ottawa ON K1H 8M5

Doctoral Thesis External Examiner Report **December, 2011**

Candidate: Nicholas Ali
University of Ottawa

Examiner: Graham E. Caldwell, Ph.D. Graham Caldwell
University of Massachusetts Amherst

Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing

Examiner's Report

General comments: In this thesis, the candidate examines single-leg landings from various vertical height and horizontal distance combinations, and attempts to relate kinematic and kinetic variables from these landings to anterior cruciate ligament (ACL) loading and injury risk. The candidate presents his work in a series of 5 papers (Chapters 2 to 6), with Chapter 1 serving as an overall Introduction and Chapter 7 as an overall Discussion. Papers 1 and 2 are reviews of the current literature concerning ACL biomechanics and injury, papers 3 and 4 describe the experimental studies that used a rigid body inverse dynamics approach to investigate the single-leg landings, and paper 5 describes the development and use of a musculoskeletal model (MSM) for estimating internal forces that cannot be measured or computed with the rigid body approach.

Strengths:

- ***Important clinical issue*** – ACL injuries are an important clinical issue, and for some unknown reason, female athletes have much higher injury rates compared to males.

- ***Use of MSM techniques*** – In the latter half of the twentieth century, the most common biomechanics modeling technique used rigid body models and inverse dynamics to analyze segmental motion and compute the underlying resultant moments and reaction forces that act at individual joints. More recently, musculoskeletal models (MSMs) have become more commonplace, permitting the estimation of forces within specific tissues (muscle, ligament, and bone-on-bone forces) that could not be performed with inverse dynamics. The candidate uses both rigid body models and MSMs in this thesis.

- ***Knowledge of ACL literature*** – The 2 review of literature chapters (papers 1 and 2) demonstrate a good knowledge of the literature concerning ACL biomechanics and injury risk.

Weaknesses:

- ***Lack of anatomical description of the knee structures and the role of the ACL within this overall structure*** – Given the thesis topic, early in the thesis it would be appropriate to include a detailed description of the knee anatomy and function, including clear diagrams of the ACL, its location, and its role within the complete milieu of ligaments, muscles, cartilage and bones that form the knee structure. This description (and accompanying diagrams) should make very clear why jumping from various heights and distances might be expected to cause ACL injuries, thereby helping to build the rationale for the experimental work to follow.

- ***Duplication of review of literature material in papers 1 and 2*** – Although I understand that papers 1 and 2 were written for separate publication in academic journals, there is much overlap between the 2 chapters. From the perspective of the thesis document, I think the review of literature would be much better served if written as a single chapter. The 2 submitted papers could be included as Appendix material.

- ***Possible lack of awareness concerning use of optimization techniques such as simulated annealing and genetic algorithms in the biomechanics literature*** – While reading the Introduction and paper 1, I was intrigued by the author's contention that present study approaches are inadequate and that he was proposing to use new state-of-the-art artificial intelligence (AI) tools and techniques. However, much of the text was vague and lacking details. It was not until near the end of paper 1 (page 45) that I discovered that the AI tools include optimization techniques such as simulated annealing and genetic algorithms. Although the author may (or may not) be correct in saying that there are no non-contact ACL injury papers that use these techniques, simulated annealing is a commonly used optimization technique in the biomechanics literature, and has been for over 10 years. The tone and vagueness of the author's writing implies that these are new techniques that are at the heart of a new, integrated study approach that is better than those presently used in biomechanics research. I disagree, and wonder if this is poor writing, a difference in terminology associated with the author's background training, or is the author unaware that these techniques are commonly used in biomechanics research?

- ***Inconsistency between "gap" study described in papers 1 and 2 with subsequent experimental papers 3, 4, 5*** – In papers 1 and 2, the author's viewpoint on currently used study approaches is clear. A main point of both papers 1 and 2 is that ACL injuries are multi-faceted, and current approaches that try to elucidate the role of a single risk factor are inadequate. In paper 2, the author describes a better approach that would incorporate multiple risk factors within a unified research approach. Because these papers formed the literature review that was to identify "gaps" in the literature and therefore provide the rationale for the author's doctoral work, I was expecting that the subsequent experimental and modeling efforts would follow this multi-faceted approach. However, papers 3 and 4 use the typical biomechanics approach that the author had criticized in papers 1

and 2. Even in paper 5 where the author describes a MSM, it is used to further analyze the same conditions (and same experimental data?) as in paper 4, and not in the manner described in papers 1 and 2.

- ***Lack of lateral and medial jump directions in papers 3, 4, 5*** – It is clear from the literature that one situation that puts the ACL at risk is movements that include a component in the medial-lateral direction in addition to anterior-posterior motion, such as "cutting" maneuvers during running. Why did the author choose to vary vertical height and anterior-posterior distance in the landing conditions, but not medial-lateral distance?

- ***Incomplete description of results in papers 3, 4, 5*** – The landing experiments that form the basis for papers 3, 4 and 5 will have produced a wealth of kinematic and kinetic data that describe the time-varying changes that occur as subjects prepare and execute their landing. However, the author has chosen to describe and present very little of these data. In the first of these papers (chapter 4), there are no time series data reported at all, making it difficult for the reader to appreciate how the subjects reacted to the different landing conditions. The only data reported are peak vertical and posterior GRF, plus values for some joint variables at the time of these peak GRF occurrences. One variable was knee joint work, which is calculated by integrating the knee joint power curve over some time of interest (which is not described). How are we to interpret these single value data? Do these variables also reach their peak at the time of peak VGRF or PGRF? It is inappropriate to use that single value to represent joint motion during landing execution. For example, having a knee flexion value of –33 degrees (Table 1, page 94) at the time of peak VGRF does NOT indicate the degree of knee flexion during the landing phase; it is only one measurement from a time series of knee flexion angles. These data form the basis for correlations with VGRF (Table 2), and the correlations are then interpreted with statements such as (page 96) *"Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings."* This is incorrect, as the author has not assessed the amount of knee flexion in each landing, only the knee flexion angle that occurred at peak VGRF. This "single value at time of peak GRF" is repeated in papers 4 and 5, and can lead to incorrect conclusions on any variable assessed. There are some time series data shown in papers 4 and 5, and some bar charts of gender-specific muscle forces in paper 5. In my opinion, more of these data should be reported in all 3 experimental papers.

- ***Incorrect interpretation of at least some correlation data in papers 3, 4, 5*** – At least some of the correlation data in these chapters have been interpreted incorrectly. For example, in paper 3, peak PGRF data are plotted as a function of horizontal distance jumped in Figure 2, page 95. Notice that on the vertical axis, the PGRF values are all negative, which is an indication that the posterior direction has been assigned to be negative, while the anterior direction is positive. Further, notice that as you scan across the graph from lower horizontal distances (30 cm) to

higher ones (50 and then 70 cm), the PGRF values INCREASE in magnitude (from ~-0.6 to -0.8 for the mean). Because of the negative values assigned to the posterior direction, this forms a negative slope on the graph, and the author reports this negative correlation as *"The other significant finding of this study..."* (page 93, in Results). However, the author mis-interprets this negative slope when he states on page 97 *"Our results ...... there will be a REDUCTION in peak PGRFs for landings performed at increased landing distance"*. This is particularly troublesome for the GRF data, as this statement of reduced horizontal force with increased jumping distance runs contrary to Newtonian physics: with increased horizontal jump distance, the horizontal take-off and landing velocities MUST increase, and the horizontal landing impulse (force X time; area under the force-time curve) MUST increase to bring the horizontal velocity to zero upon landing. One would expect the peak PGRF values to also increase in magnitude (as they do), although it is possible for the impulse to increase but not the peak PGRF. This level of mechanics knowledge should be well within the capability of a doctoral student in biomechanics. The author should carefully check the interpretation of ALL correlations, especially ones that include positive or negative signs that indicate direction (e.g. force vector components, joint angular velocities, joint moments).

- ***Incomplete description of subject population(s) in papers 3, 4, 5*** – In paper 3, there are 6 male subjects. In paper 4, there are 6 male subjects and 5 female subjects. Are these the same male subjects in both studies? Are the data from paper 3 and 4 from the same experimental data collection, or from 2 different data collections? In paper 5, there are 3 male and 3 female subjects. Are these a subset of the subjects in papers 3 and 4? Why is EMG data only reported for the 6 subjects in paper 5? If any of the subjects / data are the same in the 3 papers, this should be noted when describing the subjects in papers 4 and 5.

- ***Poor statistical power in papers 3, 4, 5 due to small subject numbers*** – In the 1970s and 1980s, it was normal for biomechanics studies to have relatively few subjects due to the tedious and time consuming data analysis procedures (cinefilm methods with hand digitization, force plate data that needed to be carefully synchronized, and all data reduction and analysis performed with custom written software). However, in the past 20 years we have seen the advent of automated motion capture systems which seamlessly integrate time synchronized kinematic, kinetic and EMG data, and off-the-shelf 3D analysis software (e.g. Visual 3D) and MSM software (e.g., OpenSim, AnyBody). With this improvement in data handling we have seen larger numbers of subjects in biomechanics studies, which brings greater statistical power. Why are so few subjects used in the studies described in papers 3 and 4, and particularly in paper 5? Did the author perform a statistical power test *a priori* that suggested such low subject numbers?

- ***Incomplete description of MSM in paper 5*** – In paper 5, the author uses subject-specific MSMs to predict the forces in internal body tissues. However, the model is not described in sufficient detail, with only general statements used such as *"The GaitFullBody MSM was ... individualized for each subject"* and *"... the model is*

made subject-specific by employing a length mass fat scaling algorithm that uses the anthropometric data measured for each subject to scale the MSM". What data are used as inputs to the model? What anthropometric measures were used in the scaling? How many muscle models are included in the model? Are differences in individual subject joint strengths (measured with a dynamometer), or muscle morphology (from MRI or ultrasound) included in the subject-specific models? Were the muscle model force-velocity, force-length and elastic characteristics subject-specific? Was the force plate data used as input to the model, or did the model include a foot – floor interface that would generate GRFs as model outputs? How did the MSM generate its muscle model activity timing as seen in Figure 2? Was there an objective function that was optimized? Were there constraints on the solution? How were they imposed, as "hard constraints" or as penalty terms in the objective function? Which optimization algorithm was used (e.g. simulated annealing)? A much more complete description of the MSM and how it was tailored to each subject is needed.

- ***Use of gait data in model "validation"*** – In paper 5, the author describes the use of *"gait data collected during our study"* for purposes of validation. What gait data were collected (none was described in the experimental procedures)? Was it for the same subjects? Running? Walking? What was the progression speed? Was the gait at constant speed, or were the subjects accelerating or decelerating? Were the foot – floor interface parameters the same for gait as in single-leg landing? Should they be? And even if the gait model results were compared to literature values as in Table 1, how do we know the MSM will be valid in an impact situation with sudden deceleration such as in single-leg landing? In the absence of a comparison between model and experimental data from the single-leg landing trials, I am unconvinced that the model should be considered validated as the author states. How well do model kinematics match experimental kinematics? How well do model GRFs match subject GRFs? Did the author perform a sensitivity analysis to see which model parameters have the largest impact on the model results?

- ***Omission of knee ligaments (including ACL) in MSM*** – In papers 1 and 2, the author champions the use of MSMs that will allow the estimation of internal forces acting on tissues within the body, important data that cannot be measured due to ethical considerations, and cannot be computed by standard rigid body inverse dynamics models. In paper 5 the author describes the use of a MSM, but I was very surprised to find that the MSM did NOT include the ACL, which of course is the main topic of the doctoral thesis. Why was the ACL (and the other 3 major knee ligaments) omitted from the MSM? Given the title and topic of the thesis, what was the rationale for leaving the ligaments out of the model? Surely the force (stress) and strain that the ACL undergoes during the landings would be a valuable addition to the thesis?

- ***Data for males and females not reported separately in paper 5*** – In paper 5, the data and correlations in Table 3 are reported for all 6 subjects in aggregate, even though the purpose is to compare the male and female groups. The separate male

and female data should also be reported, and indeed are the critical data needed to compare between male and female responses.

Understanding of the subject matter: The candidate seems to understand the subject matter, as the review papers 1 and 2 display good knowledge of the extant literature concerning ACL injury. He has also chosen an important topic to study.

Contribution of the thesis to advancing knowledge: This is difficult to judge until the data in papers 3, 4 and 5 are described in more detail.

Research methodology: The motion capture, force measurement and EMG data collection techniques used by the author are well established in the biomechanics community, as are the use of rigid body inverse dynamics models and musculoskeletal models. Due to lack of written detail, it is difficult to know whether the musculoskeletal models are really "subject-specific" as the author claims, and it is difficult to know how well these models represent the subject movements during the single-leg landing tasks. I do believe that the studies are under-powered due to low subject number.

Analysis of results and value of conclusions: As described in the **General Comments** section above, the data in papers 3, 4 and 5 are not described in sufficient detail. This makes it impossible to fully understand the results of the experiments, and therefore the value of the conclusions. In my opinion, there are incorrect interpretations of at least some of the correlation data presented, leading to some incorrect conclusions.

Organization, writing style and presentation of material: The organization of the thesis is logical, beginning with review(s) of the literature as a preamble to the experimental work. The writing style itself is fine, although in many cases the author is vague and does not include sufficient detail. As described in the **General Comments** above, I have major issues with the lack of detail in the material presented in papers 3, 4 and 5. I also think that chapter 7, currently titled "Discussion", would be better described by a title such as "Summary and Future Studies". As it stands now the chapter is not really an integrated Discussion of the thesis findings, but rather a serial summary of each of the 5 papers, followed by recommendations for future research. If it is to retain its current title, the chapter needs substantial revision to include integration of the important aspects of the different papers that is not present in the separate chapters themselves.

Revisions considered necessary in order for thesis to be accepted: Please refer to the **General Comments** section above for issues that, in my assessment, should be addressed in some manner before the manuscript can be evaluated for acceptance.

FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES

ATTESTATION DU DIRECTEUR OU DE LA DIRECTRICE DE THÈSE

Université d'Ottawa | University of Ottawa

FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

STATEMENT OF THESIS SUPERVISOR

VEUILLEZ SOUMETTRE CE FORMULAIRE À LA FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES.

PLEASE SUBMIT THIS FORM TO THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES.

NOM DU CANDIDAT OU DE LA CANDIDATE - *NAME OF CANDIDATE*	N° D'ÉTUDIANT/E - *STUDENT NO.*	GRADE POSTULÉ - *DEGREE SOUGHT*
Nicholas Ali	5033260	☑ THÈSE DE DOCTORAT *DOCTORAL THESIS* ☐ THÈSE DE MAÎTRISE *MASTER'S THESIS*

UNITÉ SCOLAIRE - *ACADEMIC UNIT*
School of Human Kinetics

TITRE DE LA THÈSE - *TITLE OF THESIS*
PREDICTING RISK FACTORS OF NON-CONTACT ANTERIOR CRUCIATE LIGAMENT INJURIES DURING SINGLE-LEG LANDING

NOM DU DIRECTEUR OU DE LA DIRECTRICE DE THÈSE - *NAME OF THESIS SUPERVISOR*
D. Gordon E. Robertson

UNITÉ SCOLAIRE - *ACADEMIC UNIT*
School of Human Kinetics

EN MA QUALITÉ DE DIRECTEUR/DIRECTRICE DE THÈSE, J'AI EXAMINÉ CETTE THÈSE ET JUGE QU'ELLE MÉRITE D'ÊTRE SOUMISE AU JURY.

UNE AUTORISATION ÉCRITE A ÉTÉ OBTENUE POUR LA REPRODUCTION DE TOUTE MATIÈRE DÉJÀ PUBLIÉE QUI PARAÎT DANS CETTE THÈSE. DANS CHAQUE CAS, UNE COPIE DE L'AUTORISATION EST INCLUSE DANS LA THÈSE.

AS THESIS SUPERVISOR, I HAVE EXAMINED THIS THESIS AND CONSIDER IT ACCEPTABLE FOR SUBMISSION TO THE JURY.

WRITTEN AUTHORIZATION HAS BEEN OBTAINED TO REPRODUCE ANY COPYRIGHTED MATERIAL WHICH APPEARS IN THE THESIS. IN EACH CASE, A COPY OF THE AUTHORIZATION IS INCLUDED IN THE THESIS.

12 Oct 2011
DATE

(DIRECTEUR/DIRECTRICE DE THÈSE) SIGNATURE *(THESIS SUPERVISOR)*

RÉSERVÉ À LA FÉSP *FOR USE OF FGPS*
DÉPÔT DE LA THÈSE - *THESIS SUBMISSION*
DATE SIGNATURE

ESUP-5262 PDF 2003/03

Lise Daze

From: Lise Daze
Sent: Thursday October 20, 2011 9:09 AM
To: 'Gholamreza Rouhi'
Cc: Gordon Robertson; hksecr; FSS Recherche
Subject: RE: Doctoral thesis deposit/evaluation

Hello Dr. Rouhi,

Thank you so much for this confirmation, it's very appreciated.

Best,
Lise

-----Original Message-----
From: Gholamreza Rouhi [mailto:grouhi@uottawa.ca]
Sent: Wednesday October 19, 2011 10:15 PM
To: Lise Daze
Cc: grouhi@uottawa.ca; Gordon Robertson; hksecr; FSS Recherche
Subject: Re: Doctoral thesis deposit/evaluation

Thanks for your email, Lise. This is to confirm that I'm acting as Mr. N Ali's PhD thesis, and also approve that his thesis can be submitted to the examiners.
Regards,

--
Gholamreza Rouhi, PhD
Assistant Professor, Faculty of Biomedical Engineering, Amirkabir University of Technology, Tehran, Iran

> Hello Dr. Rouhi,
>
> We have received a signed Statement form to confirm Mr. Nicholas Ali's
> thesis submission from Dr. Robertson to the Faculty of Health Sciences.
>
> I have been informed that you are out of the Country but still acting
> as Co-Supervisor for Mr. Ali, if this the case, we would need you to
> confirm that you approve of the thesis for its submission simply by
> responding to this message with a confirmation.
>
> Best regards,
> Lise
>
>
>
> Lise Dazé
>
> Adjointe scolaire, thèses et de la diplômation Academic Assistant,
> Thesis and Graduation Faculté des études supérieures et postdoctorales
> Faculty of Graduate and Postdoctoral Studies Université d'Ottawa /
> University of Ottawa Pavillon Hagen Hall, pièce 107/room 107
> 115 Séraphin-marion, Ottawa, ON K1N 6N5
> tel: 613-562-5800 x 1268
> fax: 613-562-5992
>

PREDICTING RISK FACTORS OF NON-CONTACT ANTERIOR CRUCIATE LIGAMENT INJURIES DURING SINGLE-LEG LANDING

BY

NICHOLAS ALI

PhD Thesis submitted to the
Faculty of Graduate and Postdoctoral Studies
in partial fulfillment of the requirements for the
Doctor of Philosophy at the Faculty of Health Science
School of Human Kinetics
University of Ottawa

Abstract

The literature suggests that body kinematics and musculoskeletal differences are major factors contributing to the high disparity in non-contact ACL injury rate between genders. The literature also indicates that the incidence of non-contact ACL injury predominates during single-leg landing sports such as basketball, soccer, and handball. Despite this, there are few studies investigating kinematic or musculoskeletal differences between genders during single-leg landing from increasing vertical heights and horizontal distances. The objective of this study is threefold: first, conduct a gap study identifying the barriers to predicting mechanisms and risk factors to non-contact ACL injury. Second, propose a new approach that can address many of the challenges encountered in many existing non-contact ACL injury study approaches. Finally, whilst determining whether or not gender differences explain the higher rate of ACL injuries among females, identify and correlate the biomechanical and musculoskeletal variables significantly impacted by gender, vertical landing height, and/or horizontal landing distance and their interactions to various ACL injury risk predictor variables during single-leg landing. Experiments using male and female subjects, biomechanical analysis using Visual3D, and musculoskeletal modeling using AnyBody Modeling System were approaches used to explore these objectives. Salient findings from this dissertation includes but are not limited to, non-contact ACL injury that occurs during single-leg landing is mutifaceted entailing many factors which cannot be captured in any one existing ACL injury study approach. Non-contact ACL injury during single-leg landing may not be gender specific. Both height and distance of landing increase the risk of non-contact ACL injury during single-leg landing. Body kinematics during single-leg landing may not be the sole determinant in attenuating ground reaction forces and consequently risk of ACL injury. The hamstring and gastrocnemius muscles were determined to strain shield the ACL while the quadriceps was found to have no significant effect on risk of ACL injury during single-leg landing. Within the findings and

limitations of this study the knowledge garnered from this research can aid in tailoring future studies so as to enable more robust non-contact ACL injury prevention protocols.

SECOND EVALUATION

Christine Bourbonnais-Hendley

From: Christine Bourbonnais-Hendley
Sent: Friday, February 01, 2013 4:27 PM
To: nali065@uottawa.ca
Cc: gc@kin.umass.edu; Michel Labrosse; elemaire@ottawahospital.on.ca; Gordon Robertson; 'Michael Pierrynowski'; grouhi@uottawa.ca; Benoit Seguin; FSS Recherche; hksecr
Subject: Evaluation of your revised thesis
Attachments: DOC.PDF; DOC.PDF; DOC.PDF

Good afternoon Mr. Ali,

The Faculty of Graduate and Postdoctoral Studies (FGPS) has received four evaluation reports of your revised thesis. I regret to have to inform you that the examiners have found that even with additional extensive revisions, your thesis still fails to meet the standards for a doctoral degree. Please find, in attachment to this email, a letter from Dean Hastings, the procedures for an appeal and the comments from the evaluation of your revised thesis.

If you have any questions, please do not hesitate to contact our office.

Regards,

Christine B. Hendley
Gestionnaire des services aux étudiants et aux facultés (2e et 3e cycles)
Manager of Services to Graduate Students and Faculties
Faculté des études supérieures et postdoctorales /
Faculty of Graduate and Postdoctoral Studies
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uOttawa

Université d'Ottawa
Faculté des études supérieures et postdoctorales

University of Ottawa
Faculty of Graduate and Postdoctoral Studies

January 30, 2013

Mr. Nicholas Ali
306 – 589 Rideau Street
Ottawa ON K1N 6A1
Nali065@uottawa.ca

Dear Mr. Ali:

The Faculty of Graduate and Postdoctoral Studies (FGPS) has received four evaluation reports of your revised thesis. I regret to have to inform you that the examiners have found that even with additional extensive revisions, your thesis still fails to meet the standards for a doctoral degree. According to FGPS regulations you must withdraw from the program and your file will have to be closed.

You may appeal this decision to the Executive Committee of the FGPS by writing to Dr. Margaret Moriarty, Secretary General of the FGPS (University of Ottawa, Hagen Hall, Room 105, 115 Seraphin-Marion, Ottawa ON K1N 6N5) within 10 working days following receipt of this letter. Please refer to paragraph 10 of the enclosed document on Appeal Procedure.

In order to help you with your decision, I have also enclosed a copy of the four reports.

I deeply regret the disappointment this news will cause you.

Yours sincerely,

Ross Hastings, Ph.D.
Acting Dean

c.c.	D. Benoit	G. Caldwell	M. Labrosse
	E. Lemaire	G. Robertson	G. Rouhi
	B. Séguin	L. O'Reilly	N. Carter

Encl.

613 562-5742
[illegible]

115 Seraphin Marion
Ottawa ON K1N 6N5 Canada
www.uOttawa.ca

Regulation of the Faculty of Graduate and Postdoctoral Studies (FGPS) - University of Ottawa
REVISION OF MARKS

PREAMBLE

1. The University recognizes the right of all students to see, on request, all tests, assignments or examinations after they have been marked.

2. Graduate students who are not satisfied with a mark they have obtained should first approach the professor and, if necessary, the director of graduate studies of the department concerned to request a revision of the mark assigned.

APPEAL PROCEDURE

1. Graduate students may appeal the attribution of any mark for any written test, assignment or examination with which they are dissatisfied, provided they submit to the Dean of the Faculty of Graduate and Postdoctoral Studies a written request for revision within four weeks of the first communication of the mark in question.

Such a request shall include:

a. the title of the course, an identification of the assignment, test or examination in question, the mark obtained and the name of the professor (or professors) whose mark is in question;

b. a statement of the grounds of the appeal.

2. A copy of the student=s request shall be forwarded to the professor, who may submit written comments to the Dean.

3. Two weeks after the receipt of the student=s request, the Dean shall appoint one or two qualified evaluators to re-assess the assignment, test or examination in question.

4. The evaluators shall be provided with a copy of the student=s request and of the comments of the professor. They shall review the entire assignment, test or examination in question and provide the results of their individual evaluations to the Dean as soon as possible.

5. The Dean, in the light of all evaluations, shall determine the revised mark, which may be identical to, lower or higher than the original one.

6. The Faculty of Graduate and Postdoctoral Studies shall inform the student by letter of the result of the appeal within a reasonable time of receiving the report of the evaluator(s). A copy of the letter shall be sent to the professor whose mark was appealed.

7. A student cannot withdraw such an appeal once the revised mark has been assigned.

8. An appeal from the revised mark may be made to the Senate Committee for the Study of Individual Cases, either by the student or by the professor, on the grounds that the evaluation was not properly carried out. Unless exceptional circumstances are shown, such an appeal must be made within two weeks of the date of the letter informing the student of the mark assigned as a result of the re-evaluation. If the appeal is successful, the Faculty of Graduate and Postdoctoral Studies shall be directed to proceed to a new evaluation, the results of which shall be final and binding.

9. Nothing in this procedure prevents a student from discussing examination questions, including the type of answers expected, with the professor and/or the department concerned. Such consultation is not a prerequisite to, nor can it be used to extend the time limit provided for in article 1.

10. Comprehensive examinations, thesis evaluations and thesis defences, being conducted by a panel of examiners in accordance with established procedures, are not subject to the appeal provisions of this regulation. Their decisions may, however, be appealed to the Executive Committee of the Faculty of Graduate and Postdoctoral Studies, which, depending on the nature of the complaint, will take appropriate action to ensure that it is clear that justice has been done. If the student is not satisfied with the outcome of such action, he may appeal to the Senate Committee for the Study of Individual Cases on the grounds that appropriate procedures have not been followed.

(80-GAO-07)

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Université d'Ottawa
Faculté des études supérieures
et postdoctorales

University of Ottawa
Faculty of Graduate and
Postdoctoral Studies

EXAMINATEUR « A »

EXAMINER « A »

Dr. Edward Lemaire

Nicholas Ali – Thesis Review

Understanding of the Subject Matter

The student has made progress in his understanding of the subject matter; however, the statistical analysis of the data and conclusions raised from the methods and results indicate that an improved understanding of various research aspects is needed. The thesis is written as if correlations imply a "cause and effect", which is not the case.

Contributions of the Thesis

This thesis expands on the data collected in past research but the outcomes did not provide additional information to our understanding of single leg landing (i.e., jumping higher or farther increased GRF and people flex their lower limbs more). The model has validity concerns and the statistical analysis approach is questionable.

Research Methodology

The methodology and conclusions typically do not match up, with conclusions being made that are not supportable by the study methodology. Statistical approaches are questionable for some aspects of this study. The majority of issue are with Paper 5, followed by Paper 4.

Analysis

As mentioned above, issues in the 3 research papers remain concerning the results and the conclusions. While better than the last version, tables of outcome data are still required for some results.

Organization, Writing Style

The writing style is adequate, with various suggested edits listed in the document. Improvements in figures are required to facilitate data evaluation.

Overall Revisions and Comments

- The responses have not changed my perspective that the "AI" approach paper should be removed from the thesis. This idea has not been implemented or evaluated and the feasibility of accomplishing this idea is questionable. A short summary of this idea could be included in the future work section of the thesis.
- Formatting discrepancies exist throughout the document. Please follow one format. Various wording/format edits are marked in the text. Margin format is incorrect (left margin too small)
- This document summarizes issues with the paper. Specific edits are listed on the paper copy.

- After reading the thesis it seems as if the correlations are performed on all 9 conditions, which makes interpretation difficult since some factors are more sensitive to height rather than distance changes.

Abstract

- A statement is made that few studies look at different heights and distances for single leg landing; however, this may be because the existing studies answer the research question
- Objective 2, a new approach, is not used in the rest of the thesis. Therefore, the proposed approach is questionable (i.e., if the idea is appropriate, why not use this approach?)
- For the final question, if females have a higher rate, then it is obvious that gender differences exist

- #3: the comment was to use be specific when referring to risk factors, since the readrt often has difficulty knowing what factors are being discussed. The author's response indicates that the comment was not understood.
- #4: the author's only argument about not using this proposed method is that other people with more money, equipment, skills, and resources could try. This is not a valid reason and would indicate that the proposed method is not feasible.
- #10: the comment was that the impact of negating arm movements should be considered in the discussion. A PhD candidate should be able to understand the biomechanical influence that are introduced by the selected methods. From the response, it is unclear whether the candidate understands that not allowing the participants to use their arms changes the task. The last comment seems to indicate that the arms are not useful for adding moments to affect body motion, which is untrue.
- #12: This study looks at landings, so the candidate should have an understanding of the loads when someone lands, from a variety of takeoff methods. For example, the candidate should be able to report the range of lower limb kinetic and kinematic values for these landings and discuss where the thesis results fit into this range. Jump and drop can both be single leg landings

Background

- Page 1: The author indicated that the best method for ACL injury analysis is simultaneously addressing multiple risk factors, but this was not done. So why was this not attempted?
- Page 2: "simulate a 3D rigid body model in Visual3D", reword since the model was not simulated by an actual "3D rigid body model"
- Page 3: this study does not use "whole body movement" for the loading task since the arm movement was constrained

Questions

- Risk factors for ACL injury: How can you identify injury risk factors when no injury occurred? How can you be sure that the same loading patterns would exist in an injury situation? This question needs to be revised since it is more related to the methods

- Gender: Similarly, the same issues come up for the gender injury statement
- Multifactorial: This question and section should be removed

Objectives

- #3: what is meant by "significantly impacted by main effects"? Please reword.

Rationale

- The rationale is based on the idea that few studies exist in the target area so more studies should be done. However, the candidate does not convince the reader why these additional studies are needed? For example, if previous landing studies showed that forces, moments, and joint angles increase as the person jumps from a higher point or jumps further; why do we need another study to show that this results is consistent as the person adds height or distance? Was this previous outcome in question?
    - Each statement should be rewritten to provide a reason for the research beyond the number of published studies

Importance

- This section was written as if the outcomes involve ACL injury. In the current state, this thesis provides a description of single leg landing biomechanics at longer-higher distances. The outcomes will not have an impact on the items mentioned in section 1.5. This section should be rewritten to indicate how the actual outcomes of the research are important.

- Page 15, section 1.13: A discussion of ways to integrate data should come after you have developed a reliable method for collecting the input data. Considering ethics and current measurement technology, it is unclear how all risk factors, forces, and injury mechanisms could be measured during an injury.
- Page 17: AI is not used for movement pattern capture
- Page 17: It is not clear how AI is proposed to being used from section 1.13. What output do you expect from the AI model? This section seems to indicate that you can take 5 areas (athletic interviews, clinical studies, video analysis, computational modelling) to predict the mechanisms and risk factors of injury. This was not done in the thesis so this sections does not cover the "Role of AI in this research"
- Page 17, 1.14: Muscle models only estimate muscle forces, not determine.
- Page 18: Section 1.15 should be rewritten to include details of the scope without having to read the papers to understand this section (ex., "This gap in the knowledge" is stated but the reader is not know what gap is being mentioned).

Paper 1

- No indents for paragraphs
- As indicated in the original comments, the proposed MDO is not well supported in this paper. The author describes the problems and errors existing in current methods, but then suggests to bring these inaccurate methods together through an AI optimization method to determine when the ACL stress exceeds the ultimate tensile strength. Considering that the author acknowledges that "there

are no known body kinematic data or muscle data that precisely address position of the body at ACL injury", as well as the numerous other problems with modelling humans, you are left with a method that may not be possible to implement successfully.

  - Based on the lack of evidence to support the proposal, and that the method was not used in this thesis, this paper can be removed without affecting the thesis. In fact, removal with improve the thesis be removing this line of thought, that is a distraction from the project focus on jump landing biomechanics.

- Page 20, chapter 4: how was the data used to develop the model used for Visual 3D?
- Page 32: Can you prove that computing power or software was a limitation in past research? If yes, add references, if not, please remove. In addressing this, please consider recent literature (i.e., last 10-15 years) since we can assume that some papers in the 1970's may have had poorer computing resources.
- Page 33: Phrases such as " the associated contributing risk factors of injury" have been used in this thesis, but it is unclear to the reader what these factors include. Please define these associated factors, with examples. This was not changed from the first review.0
- Page 33: Multidisciplinary is "Combining or involving several academic disciplines or professional specializations in an approach to a topic or problem". You have mentioned multifactoral previously but not multidisciplinary ... is multidisciplinary the term you wish to use? If yes, then you should expand to tell the reader what disciplines should be working together on the problem, etc. I believe that some research groups include engineers, biomechanists, and physicians, so multidisciplinary research has been undertaken.
- Page 38: You defined video analysis is defined as qualitative and thereby excluded; however, could new automated video analysis technology be used to provide relevant quantitative information on ACL injury? For example, if you could have multiple cameras tracking soccer players in realtime until someone suffers an ACL injury, would you be able to extract useful quantitative total body information?
- Page 39: The sentence "contact methods ... have the advantage of simultaneously ...", what risk factors are included? The response to the initial comment was that the read took this out of context ... therefore you should revise the sentence or paragraph so that this does not happen.
- Page 41: As mentioned in the original comment 34, this sentence should be changed or revised. The "tissue" advantage of in vitro is not obvious in the context of the thesis and paragraph.
- Page 41: The comment #37 was not changed in the text. You defined "freedom" in the response but did not modify the text. You are "more free" with cadavers or simulations to load the limb to failure than with gait studies, so your overall "freedom" comment lacks the required specificity.
- Page 44: Comment 41 was not address in the text. The sentence should be reworded since the teaching problems are not supported.
- Page 44: The statements that problems stem from universities ..., and private sector funding and not supported. More detail is needed to explain these statements.
- Page 44: Perhaps you should consider that modelling humans is difficult and lack of advancements is because of the need for new innovative ideas, technologies, etc.

- Page 47: In the method you assume one solution to the optimization method. If you continued to vary the input you may come up with many input parameter options that achieve the within-error test. How would you handle these?
- Page 48: It is not clear how the proposed method would "reduce equipment needs, number of subjects, and testing time". To apply this method you would have to MRI scan each subject, perform all the modelling, and still collect the 3D motion data. Otherwise, you are just applying and scaling another generic model, of which others currently exist.
- Page 48: an "enabling tool" is mentioned to capture all the required data; however, the author does not describe this tool. If no detail can be provided, then this section should be removed.

Paper 2

- Comment #55: "The paper has already been published" is not an acceptable answer. Valid comments should be addressed in the text to improve the thesis document.
- Comment #58: The statement about simulated annealing not being clear is incorrect since it is well described in McLean 2008. If you are talking about another paper, please revise this section for clarity.
- Comment #60: No Figure 2 was found for Paper II.
- Page 81: An "instrumented prosthesis" is mentioned but no details are included about this device and how it could provide valid data for the target application
- Comment #64: The response to this comment does not answer the comment. Many of the inputs to the AI model would be estimates, so error accumulation would be expected. AI will only be useful

Paper 3

- Comment #90: The response seems to indicate that the findings in the literature should not be used to understand the effects of landing. Even through different methods are used, the results from different studies that report loading should be considered and they do provide information to understand knee moments for different landing situations. Therefore, data is not lacking and these results should not be ignored. Based on your response, my comments during the proposal phase were largely ignored.
- Page 90: " This knowledge provides ... ". What are you referring to by "This knowledge"? Attenuation of GRF? The knowledge provided by the study shows that load increases if you jump higher and farther and people flex their joints more to dissipate these forces. This does not provide insights into ACL injury risk. Therefore, this sentence can be removed.
- Page 91:
    - "increasing the body's angular momentum" . You are also increasing velocity for the increased horizontal distance, and thereby increasing momentum, as with the previous comment. Better to remove "angular" since linear momentum is likely also increased.
    - "Given this, the current study ..." Since this study does not test ACL injury risk, these sentences should be revised. The previous study could be revised to say " ... a factor in ACL injury, therefore this measure was included in the research".
    - Same for next "Given this ... " sentence

- Page 92: Other studies provide useful horizontal landing info. You should review these ...
    - JJ Van der Harst, A Gokeler, AL Hof - Clinical Biomechanics, 2007, Leg kinematics and kinetics in landing from a single-leg hop for distance. A comparison between dominant and non-dominant leg
    - KJ SIMPSON, L KANTER - Medicine & Science in Sports & Exercise, 1997, Jump distance of dance landings influencing internal joint forces
    - WQ Marquez, M Masumura, M Ae - Sports Biomechanics, 2009, The effects of jumping distance on the landing mechanics after a volleyball spike (2 leg landing but same outcomes as your study)
- Page 92:
    - "... heights lower than 30 cm ..." several studies use vertical heights over 30 cm, therefore this sentence should be revised. The current sentence leads the reader to believe that there is a gap in the literature for investigations of >30 cm vertical height.
    - "... relationship between vertical landing height and horizontal ...", your study also did not investigate this, since the horizontal distance was set for vertical landings and vertical height was set for horizontal landings. Make sure that the text is not written so as to mislead the reader that this aspect is covered in the study.
    - Other studies investigated multiple joint kinematics, so how can you state that these studies did not consider the contributions of other limbs?
    - " ... is important for predicting risk ...", since you are not predicting risk in this study it is better to remove this sentence.
    - What were the hypotheses for horizontal jumps?
- Page 93: Did you really use Plug-in gait or a 6DoF marker set? Plug-in gait has strict requirements for how the markers need to be arranged , and this marker set typically produces errors at the shank and foot during deep knee bend landings. Visual3D typically does not have automatic calculation of the Plug-in-Gait model.
- Comment #77: It is unclear why the recommendation to use "maximum" instead of "peak" was ignored and that the term "maximum" was considered "not valid". Even if there is only one peak, it is better to use the most descriptive term when writing. Therefore, if you are recording the maximum, say maximum, if you are recording the peak force at pushoff, then "peak" would be appropriate. For example, in figure 3, the first peak is the maximum and the subsequent peaks relate to perturbations during load acceptance.
    - The response to the 0.8s as including the takeoff contradicts the paper where you state "The landing phase was defined as 0.8 ..." (page 95). Therefore this is the "takeoff and landing phase". You may want to indicate that this approach increases the work value since you are also incorporating negative knee power during standing and takeoff, but that these additional work values are small compared to the loading response work and therefore should have little effect on the work data used for analysis.
    - You should have use event codes in Visual3D to identify landing and successful recovery and then perform the analysis between these events

- Since you used 3D analysis, do not define the kinetic as "sagittal plane". The knee likely moved out of the sagittal plant during landing. I believe that you analyzed joint flexion, so you can use this terminology.
- Page 96: Add PPMC to list of abbreviations
- From table 1,
    - post-hoc analysis could have shown no difference between 20 cm and 40 cm for trunk flexion ... or that trunk flexion decreased before increasing for 60 cm. This should be investigated in the results and discussion.
    - Likewise for PGRF (called HGRF in the table, please use consistent acronyms), post hoc analysis could have showed no difference between 20 cm and 40 cm, but the statistical test is needed to confirm. From figure 2, some people had similar or lower values at 40 cm (4 similar, 3 >, 3 <). If the one outlier with the largest PGRF forces was removed, significance could disappear between 20 and 40 cm.
- From figure 1, it is interesting that the range if values was large (approx. 3 BW). This range could be reported since these outliers could be the important ones when you look at knee injury. What was the body weight for the people at the top and bottom of the VGRF results? Was there a difference in joint kinematics for these people, as compared to the mean?
- Please combine Table 2 and 4 to include PGRF correlations in a separate column, and remove the linking lines. You can mention the additional comparisons in the text (current method shows significance but no correlation values).
    - Interestingly, ankle and knee correlations were negative, so when the VGRF increased knee angle decreased? This seems to contradict the results but is a consequence of the sign convention for knee and ankle angles (i.e., increasing negatively).
- In figure 4, it is interesting that the horizontal GRF is in the opposite direction for vertical landings at VGRFmax. It is hard to discriminate the various curves at VGRFmax, but some PGRF seem to be negative and some positive, which doesn't match up with the table. Please edit the document to better indicate how you calculate the horizontal GRF (negative is force directed away from the start point, did you take absolute value of this breaking force or measure the positive force?). Since the PGRF and VGRF maximums did not occur at the same point, should the horizontal tests have used the time at PGRFmax to calculate the other parameters?
- VGRFmax occurs at foot-flat (fig 5a)
- Comment #80: the guidelines of >0.5 being a strong correlation are not typically followed, please see my previous comments and these sites ... many more if you search "correlation interpretation strong"
    - http://faculty.quinnipiac.edu/libarts/polsci/Statistics.html
    - http://www.stattools.net/ICC_Exp.php
    - http://www.sjsu.edu/faculty/gerstman/StatPrimer/correlation.pdf
- Page 95: Fagenbaum and Darling measured knee angles at different time points than this thesis, and compared between genders instead of heights, which can account for differences.
    - Fagenbaum and Darling did not report significant effects on vertical height or more extended knees at higher heights (i.e., "Similar jump landing knee kinematics were observed

... from the 25.4 and 50.8 cm high platforms). This needs to be revised, as well as the interpretation.

- Yeow (2010) calculated all measures at maximum knee flexion angle, which was before the time point in this thesis, therefore comparison is different (knee flexion was approx half at VGRFmax)
    - Contrary to the thesis, Yeow et al. (2010) reported "a significant elevation in knee flexion angles were noted at peak GRF and at maximum knee flexion". This needs to be revised, as well as the interpretation.
- Data on hip angles during landing are available and these can be used to compare with your results. Search "hip angle single leg landing" to find these papers
- Page 106, only one paper was mentioned to corroborate the shape of the VGRF curve, but this result is common to all single leg lending papers.
- A lack of comparative data on horizontal landings was mentioned but single leg hop studies various studies could be compared with your results, although they tend to have a longer horizontal distance, and therefore larger GRF
- The ankle angle results are more difficult to interpret since you measured at the largest VGRF, which is when the attenuation at the ankle would have been predominately over (max ankle angle 15-35 deg and the values you use are near neutral)
- Page 107: The interpretation of the ankle angle and dissipation may be interpreted differently than proposed. Since you are looking at the ankle angle at maximum VGRF, more plantar flexion may mean that less attenuation is required at the smaller distances (ankle is more plantarflexed at 30 cm and less as distance increases), so the ankle is more plantarflexed at the VGRFmax point. The terms "higher angle flexion angle" and "higher knee flexion angle" may confuse the issue since the reported ankle angles decrease over horizontal distance. In your study, smaller angles are related to more work.
    - You have correlations but non-significant differences for work, power, etc. Therefore, you should revise the statements based on correlations since more work was not achieved, in a statistical sense.
    - Two items can be correlated (i.e., similar shape of the curves) but the item with insufficient change between conditions (small difference in means) would still be insufficient
- Page 107: why would the use of repeated measures ANOVA contribute to your significant main effects?
- Page 108: remove the sentence on muscle firing patterns since the study does not support this statement with data.
- In the conclusions, state that the outcomes are consistent with the literature.

Paper 4

- Abstract: be more specific in the use of "biomechanics" to describe the variables or differences (use movement or "kinematics and kinetics", etc.). Biomechanical differences could also include muscle activation or other measures, which were not covered in this paper.
- The term "energetics" is used, but most of the analysis does not focus on energy, but forces. Kinetics is a better term for this paper

- Subjects: The average Canadian female is 69.4 kg and 161 cm (males are 82.7 kg and 174 cm). Your sample has relatively tall and slim women ... does this help to explain the lack of differences?
- Page 190: In the methods you used a 3-way MANOVA but you now state that "separate ANOVAs" were used and are reported in Table 1?
- Page 120: A table of mean and SD results is needed when discussing significant differences, reference to figures is not sufficient for the reader to understand the results
  - When talking about ankle angle, indicate dorsi or plantarflexion
  - From figure 2a and b, it look as if females were more plantarflexed than males, not smaller angles
  - Why pool the data when the paper is about gender differences?
  - You need to edit the Table 1 caption to indicate which data set is being analyzed (gender or pooled)
  - In table 1, "Distance x gender" and "Height x Distance x gender" do not show any significant outcomes, why are they included?
- Page 122: why do you only have 2 numbers for marginal means?
  - If you are talking about the marginal means at each height, why do you have 2 numbers?
  - How did you calculate the "difference in marginal means"?
- The analysis on page 122 and 123 is inappropriate since the values are plotted in figure 3, means of the VGRF at each horizontal distance are mentioned and then assumptions are made. I am assuming that this analysis is on the pooled data, but this should be specified. Preferably, a post hoc statistical test would be used to determine which measures are significantly different and a table of means and standard deviations would be provided for the reader. This section can then be revised to discuss the outcomes more effectively, referring to the table when necessary.
- Page 123: how can d1 and d2 both have the largest difference? In the next sentence, you say that h3 had the largest difference?
- Page 124: It is not evident from figure 5 since the curves are all different.
- Page 125: On figure 6, it looks as if the males have the higher trunk angles
- Table 3 is for the pooled data, you need a table with the male and female results separated
- I took the table 3 data and calculated correlations for VGRF and ankle angle (-0.20798) and VGRF and hip angle (0.10257). While these are expected to be different than running the correlation on data from each individual, these values are much lower than Table 4 and would likely not be significant. This changes the discussion. Please review your calculations.
  - Also, table 2 results showed correlation differences for males and females, which should be discussed
- Page 128: you state that females landed less plantarflexed; however, you did not report ankle angle at landing (only at max VGRF). Statement should be revised.
  - Were females more plantarflexed?
- The correlation discussion may be incorrect since the total range of ankle plantarflexion was not evaluated, just the angle at VGRFmax, which could be at least half the total range.

- In the discussion, state the hypotheses again so that the reader does not have to go back in the text to search for this, and this does become a problem since multiple hypotheses were not separated out in the introduction
- Page 129: you cannot support the statement about the importance of distance without the post-hoc statistics
    - Based on the methods, you cannot calculate how much attenuation occurred at each heightxdistance, you only know that people flex more as the task becomes more challenging (i.e., we do not know if the VGRF should have been x at d30h40, but it was really <x). So you cannot make statements about attenuation.
    - The statement about higher hip flexion angle and lower peak VGRF is not as simple to discuss since you did not have a significant height effect, just distance. Therefore, your statement would not apply to vertical drop landings.
    - You state that table 4 involves the main effects of height x distance, but ankle angle was not significant, as shown in Table 1.
- Page 130: the statement that you cannot compare results with the literature is incorrect. A table to results or ranges of results could be used as comparators
    - How would repeated measures ANOVA increase the chance of significant findings?
    - For gender analysis n=6
    - Did the Power analysis not provide information on energy absorption? Investigating what contributed to energy absorption is not a limitation but another line of research
    - Since no significant difference in GRF was found between genders, you cannot say that the ability to attenuate GRF was compromised or that the females were at increased risk
- Page 131: the statement on significant associations was only for the pooled data, which is not clear from the statement
    - The statement that the study suggests that factors other than biomechanical are more involved cannot be made since the people were not in an injury situation. If they had an ACL injury, you may see biomechanical factors. Your study shows that matched males and females can accomplish the set tasks similarly.
- In the discussion, only one paragraph talk about gender differences, the text should be revised to make sure that the reader understands when pooled data is being discussed.
- This is predominately a paper on pooled data with a similar analysis to Paper 3, but with more subjects. If this pooling is appropriate, then why not do this for Paper 3 and remove the analysis from Paper 4? You would have a larger n

Paper 5

- Page 136: Since you showed in paper 4 that gender was not a factor for the tasks, how can you use this data to provide an understanding of gender differences?
- Page 137: It is difficult to make a statement that "level of effort" is the reason MSM are not used since the main issue is likely that we have not created a reliable MSM that can be applied across people that differ from normal

- Page 139: You need to build on Paper 4 for the hypotheses, etc. for this paper 5. Therefore, you already know that there was only 1 gender-based difference (ankle angle) so you cannot continue to assume that the 2 groups are different for "lower extremity kinematics" , "VGRF", etc.
    - Since you know that the input data are similar, how can you hypothesize that the model would provide significantly different reaction and muscle forces?
- Page 140: Why is the subject selection for Paper 5 a poorer match than Paper 4?
- Page 142: Remove value statements about how "time consuming" research can be. Better to just say what you did.
- Page 143: You need to say how you calculated experimental kinematics.
- Be clearer as to what was done by AnyBody and what was done externally using another method
- Page 144: Please separate methods and results
    - What EMG data is being presented? How many subjects? ...
    - The actual EMG occurred before the modelled EMG. You state that this was expected since the model does not include latency due to muscle response to a stimulus. However, this would result in the muscle model EMG occurring before the measured EMG (i.e., since the muscle model would not have this latency). Please revise this thought
    - Why use a correlation to test the difference? The difference in values are more relevant for timing (i.e., comparing onset and duration values, means, etc.).
    - Please provide a table of the onset and duration for EMG for comparison (mean and SD). The difference in Figure 2 are rather large, how can you consider this valid?
    - Why not test from foot contact to double support?
    - Based on validation 1 that was presented, I would consider that the model was not valid!
- Page 146: For validation 2, you found discrepancies that could provide a 25% error in Fz, your main outcome measure but did not correct this in the model. This does not support validity for the model.
    - Also, how would declining to revise the model make it more reproducible?
- Revise all papers to show that you are presenting takeoff and landing, not just landing
- Section 2.3: You did not prove validity in the previous section
    - EMG and other such methods can be moved to 2.1
    - Statistical comparisons for gender should be removed with an n=3 (n-1=2). Just use descriptive statistics
    - Figures 5 and 6 have many lines per graph. You can keep this in the document since it does show general shape of the curves, but you should not use this as a source when discussing differences
    - Why are the joint angles in table 3 so different that the angles in Paper 4, Table 4?
        - VGRF results show that these groups are different than Paper 4, so the subject matching may not be appropriate
    - Page 153, while all ANOVA statistics should be removed, the statement that the largest differences must be significant cannot be made. You need to perform a post-hoc test on the results. Since n-1 would be only 2 this is unadvisable.
    - Are the correlations performed on pooled data? If you have shown differences in gender, then how can you validly pool the data?

        - What is correlated? All data for all conditions for all subjects?
    - Figure 7: replace with a 2D graph to make to easier for the reader to compare males and females
- Page 156: you did not show reasonable agreement, and no definition of reasonable agreement was provided and supported
- Section 4: As with section 2,3, the statistical analysis should be removed
    - No hamstring/quadriceps ratio reported in results
    - Axial compressive force is higher since VGRF is higher
    - Page 158: Given the MSM, if the relationship between the PTASF and quadriceps force expected
    - You have shown than a greater external force on the body (VGRF) makes a MSM calculate greater forces at the knee and for the muscles around the knee (quads and hamstrings). This does not show that hamstring muscles reduce VGRF
    - Since you only examined forces at VGRFmax, you cannot make statements about ACL strain over the entire range of knee flexion
    - Since you seem to have combined all measures, was the correlation really due to change in horizontal distance (i.e., a different task) instead of a modulation of PTSAF strategy. Correlation does not mean that the 2 variables are related, just that they vary similarly. The cause could be another factor.
    - Main limitation is that no injury occurred, so you are not really looking at ACL injury based on the input data.
- Please see paper: A Finite Element Analysis of a Subject Specific Single-Leg Drop Landing at Varied Heights, CY Tse, H Nayeb-Hashemi, A Vaziri, PK Canavan – 2011
- You only have one model, with different inputs (marker data for limb dimensions is also an input)

Summary

- Page 165: This is a good place to explain why you did not follow the recommendations in the review papers for the thesis research
    - The sentence starting with "Stemming from" is not supported by the review articles (i.e., the review did not support research on non-injury single leg landings)
    - Please see edits in paper version of the thesis, most of the concerns are addressed previously in this document

uOttawa

Université d'Ottawa
Faculté des études supérieures et postdoctorales

University of Ottawa
Faculty of Graduate and Postdoctoral Studies

EXAMINATEUR « B »

EXAMINER « B »

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No comments provided

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EXAMINATEUR « C »

EXAMINER « C »

Dr. Michael Pierrynowski

Doctoral Thesis Examiner's Report for a Revised Thesis

Nicholas Ali, 5033260

Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing

PART A: Evaluation

Verdict 3: The revised thesis still cannot be accepted for the defence and must undergo additional extensive revision BEFORE DEFENCE to ensure it meets the above criteria

PART B: Comments

Understanding of the Subject Matter

As stated in the Abstract to the thesis, "The objective of this study (thesis) is threefold: first, conduct a gap study identifying the barriers to predicting mechanisms and risk factors to noncontact ACL injury. Second, propose a new approach that can address many of the challenges encountered in many existing non-contact ACL injury study approaches. Finally, whilst determining whether or not gender differences explain the higher rate of ACL injuries among females, identify and correlate the biomechanical and musculoskeletal variables significantly impacted by gender, vertical landing height, and/or horizontal landing distance and their interactions to various ACL injury risk predictor variables during single-leg landing.

The doctoral candidate has provided well-written reviews (Chapters 2 and 3) that summarize his understanding of the literature regarding his stated objectives 1 and 2. Evidence of an acceptable performance is that these two thesis chapters have been published in the "Open Biomedical Journal" and the "Transactions of the Canadian Society for Mechanical Engineering".

With respect to objective three, determine if gender differences explain the higher rate of ACL injuries among females, the thesis fails to provide sufficient rationale for its focus on examining gender. Previous thesis sections argue for a multi-disciplinary approach to simultaneously examine multiple risk for ACL injury. It is an abrupt focus shift.

And with respect to gender, the candidate fails to define "gender" and how it is a risk factor for ACL injury. Is the candidate talking about sex (dichotomous variable: male/female) or gender (an individual's self-perception of his/her male/female identity, continuous variable, say 0=super male, 10=super female, whatever that means to you or I)? I direct the candidate to the NIH guidelines regarding the definitions of sex and gender.

To continue, "What makes a male male! with respect to jumping/landing ability?" I might be sex=male but I would rate myself gender=2. This thesis is silent with regards to discussing the role of socialization with respect to jumping/landing ability. Gender identification seems to have at least face-validity according to this evaluator. Did the 6 males and 6 females, matched for age, height and weight, have similar or disparate physical activity profiles, opportunities to have learned a wide variety of physical activities, and did they have similar health status? If for example, the women tested in this study were gender=7 and the males gender=3 it is more difficult to determine if a "sex" difference exists. And as a additional point, the literature contains several papers that discuss the role of timing within a woman's cycle and her risk of ACL injury. The candidate mentions "hormones" several times within the thesis but was this data collected from the female participants.

Contribution of the Thesis to Advancing Knowledge

This thesis has the potential to contribute to the existing body of knowledge. The experimental methodology is sound but the data processing, statistics, and interpretation are weak. Although, Papers

III, IV and V have been submitted for publication, I believe they will not be accepted in their present form. Given that the "acid-test" to say something has advanced knowledge is publication in a peer-reviewed journal, this thesis, in its present form, does not meet this test.

Research Methodology

In Paper I the candidate performs a review of the literature to identify knowledge gaps related to predicting the mechanisms and risk factors of ACL injury. To identify the relevant literature, the candidate performed recent electronic literature searches and his databases selection and keywords are provided. He then states that "The most relevant full text English articles ... were analyzed". Unfortunately, the details regarding this selection are lacking. It is unclear if high quality evidence was selected using level and grade of evidence methodology or papers were selected that discussed the area of interest regardless of quality. Proper systematic review methodology was not used.

For papers III to V, the candidate used state-of-the-art instrumentation and methodology to measure selected biomechanical variables of the lower extremity during single-leg jumps. These data were processed using Visual3D and AnyBody software. Generally, the protocols are sufficiently documented so the findings could be replicated. However, a few details are lacking. For instance, why was the forceplate data collected at 1000 Hz in paper III when the kinematics data was collected at 250 Hz? In Paper III, the order of heights and distances were randomized to reduce learning effects. What evidence do you have that the order was random and it did reduce learning effects? One could use a Latin-square design to test if order is important and to remove it as a factor. The subjects were asked to jump from a box onto the middle of a force plate. The distance from the box to the edge of the edge force plate is mentioned but what is the size of the force plate? Paper IV, Figure 1a, b, c. Are these curves registered at peak VGRF? This information is not provided in the Procedures section.

Analysis of Results and Value of Conclusions

Point 1: The candidate provides a rationale why damage to the ACL may occur when the VGRF is at its maximum. He cites a paper by Cerulli et al (2002) that had one male healthy subject hopping and landing on one leg whilst *in vivo* measured ACL strain and externally measured GRF were collected. Cerulli et al present results that showed that peak ACL strain occurred when the GRF is maximal (abstract, text). [Note: Cerulli is unclear if he is talking about peak GRF or peak VGRF. I think it is peak VGRF looking at Figure 2. Nevertheless, the candidate should have pointed out this discrepancy]. However, it must be noted that Cerulli et al. (Figure 2) show that peak ACL strain occurred ~ 2% of the hop cycle after peak GRF. Since the hop cycle takes approximately 1.5 s (Cerulli page 309) the peak ACL strain occurs ~30 ms after peak GRF. It is surprising that the candidate did not comment on this abstract/text/figure discrepancy. In fact, the candidate states that the two events align (thesis page 13, 139), occur at the same instant (page 91), and occur at almost the same instant (page 114). The rationale for using peak VGRF as the point in the single-leg jump when the subject may be at greatest risk for ACL injury may be flawed. In addition, Cerulli et al talk about GRF not VGRF and one must assume that they mean VGRF,

The link between peak ACL strain and peak VGRF is of importance since the candidate performs all of his analyses (papers III, IV, V) at peak VGRF. As one can see in Figure 1a, b, c (paper IV), the only curves where time is not normalized, a 30 ms time shift can drastically alter the magnitude of the VGRF, PGRF, knee abduction moment. Examination of the time normalized curves in all of the papers also suggest drastic changes.

If we argue that peak ACL strain and peak VGRF align, the candidate provides no convincing argument that peak ACL strain is a risk factor for injury. Again, looking at Cerulli's paper, they state that their hopping task strains the ACL but "the point at which injury may occur is still unknown."

In this evaluator's opinion it is unfortunate the candidate short-changed himself by focussing on only one time point in the landing movement. This is stated for two reasons. First, a cursory examination of several curves within the thesis (i.e. Paper III, Figure 5b, 5c; knee flexion, hip flexion) clearly shows that the knee and hip variability at peak VGRF is quite small across the experimental conditions. The use of a more holistic representation of, for instance, the knee angles, might provide stronger evidence of male/female difference for Paper IV. Second, tissue (ACL) failure is not only dependent on peak

load/strain but also on rate of loading and prior loading history (hysteresis/creep). Examination of the rate of change of, for instance, knee flexion, may again provide stronger evidence of male/female difference.

Point 2: If one accepts that peak ACL strain is the major contributor to ACL failure, and peak ACL strain is strongly correlated to peak VGRF, what is the rational for looking at trunk/hip/knee/ankle sagittal plane angles, frontal plane knee abduction moment? Some rationale is provided but these sections of the thesis must be strengthened.

Point 3: Within several Chapters of the thesis, Pearson Product Moment Correlations (PPMC) were used to identify the strengths of the associations between sets of variables. Unfortunately, no information is provided that states that this is the appropriate test. Were the data Normally distributed (tested using what test?) and if yes, then the PPMC is appropriate. If not, the Spearman Rank Correlation is appropriate. This lack of information suggests that maybe the data must be reanalyzed. I also suggest that in addition to the correlation values, scatterplots and variable histograms be provided for the reader's perusal. This presentation can be densely provided (lots of information in little space) using the statistical package R and using the pairs function.

Point 4: In a similar vein, the interpretation of a significant PPMC is not stated. For example, in Paper IV, Table 2, the PPMC between Peak VGRF and Ankle flexion, for the males, is -0.804 and this flagged as significant at $P < 0.05$. The significance level indicates that the PPMC is different than zero but it does not state that the PPMC is, for instance, greater than 0.8 which might be the threshold at which it is important. A better statistic is to *a priori* state what is the minimal PPMC that one would accept as having evidence that an important association exists between two variables. The thesis lacks appropriate testable statistical hypothesis in this regard. Just stating that a PPMC is "reasonable" (page 108) is not acceptable. Lastly, confidence intervals about the point PPMC estimates should be provided.

Point 5: Within the thesis multiple comparisons are sometimes performed (i.e. Paper III using multiple ANOVAs). However, correction for multiple tests (i.e. Bonferroni's correction) is not performed. Marginal results should not be flagged as being significant (i.e. in Paper III horizontal jump distance has a significant effect on trunk flexion ($P = 0.04$). The candidate must re-examine the results of the hypothesis testing, in light of a corrected P threshold, and then only discuss those findings that he is confident of being significant.

Point 6: In Paper V testable hypothesis are not stated. It is not sufficient to state that "... females will land with *relatively* greater peak VGRFs compared to males .... and ... males and females would demonstrate significantly *different* lower extremity joint reaction and muscle forces". What does relatively greater mean? What does different mean? Throughout the thesis all of the hypothesis must be converted to testable hypothesis and the results of parameter estimation (i.e. correlations) must state both point estimates and confidence intervals.

Organization, Writing Style and Presentation of Material

Overall, the formatting and grammar of the thesis is acceptable. However, the organization and data presentation is flawed.

Point1: In my opinion, a significant limitation with this thesis, in regards to its organization, is the inclusion of Chapter 3 (Paper II) and associated sections that argue for the need for "a multidisciplinary design optimization approach [MDOA] to aid in the prediction of non-contact ACL injury mechanisms and risk factors" (abstract, Chapter 3). Although the need for a MDOA model is well argued, the candidate did not develop nor apply such an approach to answer his stated question. In my opinion, the candidate, promised and under delivered. A possible solution, however, is to delete Chapter 3 and all associated sections from the thesis (two examples: Chapter 1, page 17 ("One such technique that can allow a systems approach to solve complex problems is AI") and page 18 ("This proposed method suggests the coupling of many of the existing non-contact ACL injury study approaches via an AI technique. Details of this new proposed methodology are presented in journal Paper II (Ali et al. 2011).") and then re-organize what remains to stay within the boundaries of what was actually done.

Point 2: I am also concerned with data presentation. Several examples follow.

In paper III, the landing phase is defined to lie within the interval -0.8 s to +0.6 s relative to peak VGRF. So why in Figures 3, 4, 5's, and 6, is the VGRF at 58%? As a reviewer, I am asking myself the question "Is the data credible?" I am having difficulty answering this question since raw data is not provided. I strongly recommend that several not ensemble averaged (i.e. individual) data be plotted and that the raw data be provided within an Appendix.

The axis labelling for the profile plots in Paper IV (Figures 3, 4, 5, 6) should be near the axes and not within the Figure captions. I know this is how SPSS outputs profile plots but they should be better formatted.

Table 3 in Paper IV would best be presented in landscape mode and is the Table title correct. Are all of these dependent variables significantly influenced by height and distance interaction as well as main effects of gender, height and distance? Also examine the Tables in Paper V.

Table 4, paper V contains PPMC among risk predictor variables. It is not customary to include the 1.00's along the diagonal. Also see Table 4, Paper IV. I also add that it is customary to use *, ** and *** for P's < 0.05, 0.01, and 0.001 (i,e do not use *, #, $)

A description of the subject characteristics is important. Self-perception of jumping ability, self-perception of gender, hormonal status, health status, and visual acuity should be included.

The Table of Contents is incomplete – no preliminary pages included, the Chapter titles are not included, no subsections included, no list of tables or figures, no Appendix and

Although I did not did not check all of your references I observed that (page 129) a series of references is missing (Colby, Decker, Kernozek. Ball).

Within two abstracts (i.e. Papers III, IV) the statistical test that is used for analysis is not stated.

In paper IV, the male and female participants had similar heights (1.72 vs 1.70 m) but dissimilar variance (0.11 vs 0.03 m) Is this a typographic error? If not, how is the reader to know that your height and mass matching was successful?

In Paper V, the capitalization on the title page is inconsistent relative to other Chapters.

In Paper V, several of the female findings (i.e. VGRF, Figure 5) are bimodal compared to the findings obtained from the males. How was the time normalization performed and is it wrong? If not, this finding must be discussed.

Revisions Considered Necessary in Order for Thesis to be Accepted

My recommended changes to the thesis are embedded within the report above. A brief (and incomplete) summary is:

Define gender versus sex and why gender is relevant.

Justify the selection of the biomechanical variables.

How were the papers selected for the Reviews of Literature assessed for quality?

Expand details regarding data collection and processing.

Is the PPMC the appropriate statistical test? Are the PPMC values correctly interpreted?

Thesis must contain raw data (plots, tables, Appendix) to allow reviewer to assess data quality.

Redo profile plots.

The hypotheses are not stated as testable hypotheses.

The interpretation of multiple statistical tests must use something like the Bonferroni correction.

Remove Paper II and all associated text within thesis.

Provide details regarding the subjects/participants tested.

Expand the Table of Contents. Add List of Figures, List of Tables

Check references for inclusion and correctness.

General Comments

I believe the thesis can make a contribution to knowledge since it embodies original investigation and analysis. However, in its present form, some justifications, some analyses, some presentations and some interpretations still require significant additions which I believe cannot be accomplished within a short time interval.

I thank you for the opportunity to read and comment on this thesis.

Michael Pierrynowski

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EXAMINATEUR « D »

EXAMINER « D »

Doctoral Thesis External Examiner Report **September, 2012**

Candidate: Nicholas Ali
University of Ottawa

Examiner: Graham E. Caldwell, Ph.D.
University of Massachusetts Amherst
Graham Caldwell

Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing

Examiner's Report

General comments: In this 2nd iteration of the thesis, the candidate addresses the concerns of the committee from the initial evaluation (December, 2011). The main focus and structure of the thesis remains the same, in that he examines single-leg landings from various vertical height and horizontal distance combinations, and attempts to relate kinematic and kinetic variables from these landings to anterior cruciate ligament (ACL) loading and injury risk. The candidate presents his work in a series of 5 papers (Chapters 2 to 6), with Chapter 1 serving as an overall Introduction and Chapter 7 being re-titled as Summary and Future Studies, rather than its original designation as an overall Discussion. Papers 1 and 2 are reviews of the current literature concerning ACL biomechanics and injury, papers 3 and 4 describe the experimental studies that used a rigid body inverse dynamics approach to investigate the single-leg landings, and paper 5 describes the development and use of a musculoskeletal model (MSM) for estimating internal forces that cannot be measured or computed with the rigid body approach.

The revised version has addressed some of my initial concerns, most notably with the inclusion of a detailed description of knee anatomy and function in Chapter 1, more complete reporting of results in papers 3 and 4, and a re-interpretation of some previously misunderstood correlation results. In some cases the candidate addressed my concerns in his response Comments sheet, but chose to make no changes to the thesis document (e.g. the rationale behind the objective function used to predict muscle forces in paper 5). In other cases the candidate apparently disagrees with my assessment (e.g. the use of single variables values occurring only at the time of peak VGRF *versus* computing how these variables change over the landing period, such as ankle or knee angle).

In my opinion there remain substantial issues with the thesis. In the following comments, the ***[Comment numbers]*** refer to the listed number from the PhD Thesis Review Sheet for Examiner B that was included with the revised thesis document.

- ***Overstatement concerning novelty of optimization techniques such as simulated annealing*** -- ***[Comment 3]*** It appears from the author's response that he is aware that simulated annealing is a commonly used optimization technique in the

biomechanics literature, and has been for over 10 years. However, the tone and vagueness of the author's writing implies that these optimization methods are new "AI" techniques that are at the heart of a new, integrated study approach that is better than those presently used in biomechanics research. From the author's responses to this and many other concerns, it is clear that he considers the issue to be that his work is *"focused on the domain of ACL injury biomechanics and NOT the entire field of biomechanics"*. I disagree, and consider his work to be an application within the field of biomechanics. It is incorrect to portray simulated annealing as a novel technique because it has not been applied to this particular application when in fact it has been used within the field of biomechanics for many years.

- ***Inconsistency between "gap" study described in papers 1 and 2 with subsequent experimental papers 3, 4, 5 – [Comment 4]*** A main point of both papers 1 and 2 is that ACL injuries are multi-faceted, and current approaches that try to elucidate the role of a single risk factor are inadequate. Yet, papers 3 and 4 use the typical biomechanics approach that the author so heavily criticizes in papers 1 and 2. Even in paper 5 where the author describes a MSM, it is used to further analyze a subset of the same experimental data reported in paper 4, and not in the manner described in papers 1 and 2. In Chapter 1, section 1.13 is titled "Role of AI in this research"; this is misleading because I do not believe that such AI techniques were used in the research described in papers 3, 4 and 5.

- ***Lack of lateral and medial jump directions in papers 3, 4, 5 – [Comment 5]*** In his response, the author explains that some lateral jump data were collected but not included in papers 3 and 4. This should be mentioned in the Methods and/or Discussion in one or both of these papers, along with the reason(s) for their exclusion.

- ***Single value data at time of peak VGRF – [Comment 5]*** Papers 3, 4 and 5 now include time series kinematic and kinetic data that describe the time-varying changes that occur as subjects prepare and execute their landing. However, the author continues to base his analysis on single values taken from these time series at the time of peak VGRF, except for peak PGRF and knee joint work. It is inappropriate to use the single value of a variable at the time of VGRF to represent joint motion during entire execution of the landing, a fact that is now readily apparent from the time series data included in paper 3 on pages 102 to 104 (Figures 5 and 6).

  For example, the ankle flexion values in Table 1 (0.22, -2.11, -2.67 degrees; page 98) and Table 3 (-7.97, -6.57, -5.02 degrees; page 100) observed at the time of peak VGRF do NOT indicate the degree of ankle flexion that occurs prior to and during the landing phase as seen in Figure 5a on page 102. These single value data form the basis for correlations with peak VGRF and peak PGRF (Tables 2 and 4), and the correlations are then interpreted with statements such as (page 106) *"For the vertical height tests we found ankle flexion angle was significantly correlated to peak VGRF (Table 2) and this suggests that ankle flexion may be effective for attenuating peak VGRFs at increased vertical height of landing."* While the

correlation may have been significant, the 2nd part of the sentence is incorrect, as the author has **not** assessed the amount of ankle flexion in each landing, only the ankle flexion angle that occurred at peak VGRF. From Figure 5a we see that perhaps the amount of ankle flexion does change with increasing vertical landing height, but to capture the amount of ankle flexion that occurs one needs to compute ***the range of motion*** that the ankle goes through during the period of interest. In fact, the ankle angle at the time of VGRF occurs during a time of rapid ankle angle change as represented by the steep slope of the curves in Figure 5a. This makes the assessment at that particular time sensitive to errors in the exact time of VGRF determination (one data frame on either side of the true peak will have very different ankle angle values), and to data reduction choices such smoothing frequency cut-offs. Perhaps this sensitivity explains why the ankle angles in Table 3 (Horizontal Distance Test, all done from 40 cm height) are so different from the 40 cm height value in Table 1 (Vertical Distance Test).

Clearly, the ankle angle at the time of peak VGRF does not represent the ankle flexion that occurred during the landing, and this criticism extends to all variables that were analyzed in this manner. This "single value at time of peak GRF" analysis is repeated in papers 4 and 5, and can lead to incorrect conclusions on any variable assessed in this manner, making the interpretation of correlations using these single values and the related discussion in papers 3, 4 and 5 suspect, if not meaningless.

- ***Subject population(s) in papers 3, 4, 5 – [Comment 8]*** In my previous review I asked about the subject populations in papers 3, 4 and 5, and learned that indeed there was overlap between the papers. In the revised thesis document there are nine male subjects in paper 3, with the same data from six of these males being reported again in paper 4 to compare with six female subjects. In paper 5, there are three male and three female subjects, who are a subset of the subjects in paper 4. In response to my query, the student included the comment *"Be aware please, however, this is an article style thesis and these manuscripts are very separate papers with different objectives, hypothesis and methods."* This is completely irrelevant, and the fact that they are three separate papers makes it even more important that the readers be made aware that some of the data has been previously reported. It is imperative in paper 5 that the subject description (page 140) includes the disclosure that the data from these subjects was used and reported in an earlier paper (paper 4). Likewise in paper 4 (page 115) you should identify which six of the nine male subjects in paper 3 were included in paper 4.

  Further, in paper 5 the use of a subset of the subjects (three males and three females) from paper 4 (six males, six females) has produced a serious problem. In paper 4 the only gender difference reported in Table 1 (page 120) was for ankle flexion angle (*"Females had significantly smaller ankle flexion angles than males"* – page 120). In paper 5 there is a gender difference reported for peak VGRF (*"females had significantly lower peak VGRF"* – page 151, data in Tables 3a and 3b). This paper 5 gender difference for VGRF was **not** seen in paper 4, and the paper 4 gender difference for ankle flexion angle was **not** seen in paper 5. Because these are the same subjects and data measurements, the only possible explanation is

that the subset of subjects selected for paper 5 was not representative of the complete paper 4 subject population. Presumably if the other three male and three female subjects had been chosen for paper 5, the gender difference would have been reversed, with females having significantly higher peak VGRF. This incongruence between the data in paper 4 and 5 leads to problems in the discussions of the papers, where in one paper your results agree with certain papers in the literature and in the other case your results disagreeing with those same papers. Indeed, paper 4 and paper 5 disagree with each other despite the use of the same subjects and data! This would presumably be solved by including all six male and six females from paper 4 in paper 5.

- ***Description of MSM in paper 5 – [Comment 10]*** In response to my criticism of the incomplete description of the MSM in paper 5, the author gave me more details of the model and included at least some of these details in the revised version of paper 5. Based on the text in the revised paper 5, the following issues with the MSM remain:
    - ***How was the MSM motion determined?*** The first part of the modeling process was to fit the MSM model to the motion of the retro-reflective markers worn by the subject. This serves to scale the model to the subject and for pose estimation: find the model positions that best represent the subject movement at each point in time throughout the time of interest. The text describing this process is on pages 142-143. (Note that this process was also done in Visual 3D for the data in papers 3 and 4, but was not described.) In the MSM, was this done using a 6 DOF model for each body segment, or was an inverse kinematics model used in which the body segments are constrained in their motion by the model joint properties?

    - ***Confusing terminology:*** On page 142, the second modeling process is described as *"Inverse dynamics analysis was used to determine the unknown joint reaction and muscle forces from the known motion."* This is confusing because the term ***inverse dynamics analysis*** refers to a method of calculating the unknown joint reaction forces and joint moments that must be present to conform to Newton's Laws for a linked-segment rigid body model, and was used as the basis for data analysis in papers 3 and 4. First introduced in the first half of the twentieth century, this method has been the most prominent analysis tool used in human body biomechanics research since the 1970s. The computed joint reaction forces and moments have limits in their interpretation due to assumptions regarding the absence of muscle forces in these rigid body models. I am sure the candidate is aware of this analysis technique, as he used it in papers 3 and 4. He is also aware of its limitations, as he further asserts on page 142 that *"Classical IDA cannot calculate muscle forces and consequently cannot be used to quantify internal joint reaction forces"*.

      The author should not use the term "inverse dynamics" in reference to the MSM which computes muscle forces. Further, he should not use the

term "joint reaction" in reference to the outputs of the MSM, because the inclusion of the model muscle force estimates means that computed internal joint contact forces will be different than the joint reaction force calculated with the inverse dynamics analysis.

- *Muscle models:* The muscle models in the MSM are described on page 143 as *"simple muscle models that did not consider the force-length and force-velocity relationships, as well as the passive stiffness of the muscles as the Hill muscle model does."* The Hill model has been used in MSM models since ~1980, and has been considered the standard model to use since at least the early 1980's when Audu and Davy published a paper comparing the merits of several different models. Why did the author not use the Hill model? Certainly this choice will influence the computed muscle forces from the MSM.

- ***Objective function for muscle force determination:*** The muscle forces computed in a MSM will depend heavily on the choice of ***objective function*** (sometimes called a *cost function)* used to determine how the resultant joint moments are to be distributed to the redundant underlying internal structures. On page 142 the author states that *"the objective function was designed to minimize the maximum muscle activity."* What is the rationale for this choice? In the author's response to my question, he stated that this cost function will reduce fatigue, but I did not find that assertion in the document. Without the benefit of a described rationale, I am at a loss as to understand why such an objective function would be chosen. The reduction of fatigue might be important for an endurance event such as walking or long-distance running, but it hardly seems relevant to a single-leg landing task.

- ***MSM not subject- and gender- specific:*** One of the stated purposes of paper 5 was to *"determine gender differences with respect to joint reaction and muscle forces."* (page 139). Yet the MSM was the same for the male and female subjects, apart from being scaled to the individual subject body size. With the known differences in male versus female anatomy such as pelvis width that can directly affect knee structure (e.g. Q angle), why did the author not use female specific and male-specific models? The choice to use the same model will likely mask some differences in predicted muscle forces between the genders. The absence of gender- and subject-specific muscle strength values will also limit the usefulness of the MSM.

- ***Use of gait data in model "validation" – [Comment 11]*** In paper 5, the author describes the use of gait data to help validate the model. The MSM was applied to a walking trial collected from the subjects at the time of the landing data collection, and used to calculate internal variables that were compared to studies in which in vivo knee data were collected (Table 1, page 146). However, even if the gait model results are comparable to these literature values, how do we know the

MSM will be valid in an impact situation with sudden deceleration such as in single-leg landing? One specific issue in that regard is the use of an objective function that was designed to minimize the maximum muscle activity, and according to the author, minimize fatigue. This may well be an appropriate cost function with which to predict muscle forces in walking, but it seems entirely inappropriate for single-leg landings. Therefore, even if the gait comparison looks good, I continue to be unconvinced that the model should be considered validated as the author states.

- ***Sensitivity analysis – [Comment 11]*** In my previous report I asked if the candidate had performed a sensitivity analysis to see which model parameters had the largest impact on the model results. The author's response was *"we did various things to acquire confidence in the model such as sensitivity studies, comparison of outputs with Visual 3D and muscle modeling studies. Again, given this is an article style thesis this information was not added to the thesis given it was deemed unworthy of publication."* I am not sure who decided it was unworthy of publication, but these are important results that can help the reader of the thesis determine how much faith to put in the model results. If they don't fit within the confines of the paper, they should be included in an Appendix.

- ***Omission of knee ligaments (including ACL) in MSM – [Comment 12]*** I continue to not understand why the MSM in paper 5 did NOT include the ACL, which of course is the main topic of the doctoral thesis. Again, why was the ACL (and the other 3 major knee ligaments) omitted from the MSM? The author's response was that *"The material properties, geometry, and constitutive law to model the four major ligaments of the knee joint is unknown or under research. The kinematics of the ACL during single-leg landing is also unknown in the scientific community."* With the title and topic of the thesis, wouldn't an effort to model the ACL path based on its origin, insertion and a series of via points (as the muscle paths are defined) be worthwhile? The author states that *"Almost all mathematical models developed to date for the knee use one-dimensional representation for the ligaments."* Thus there are some models in the literature that would serve as a starting place. It seems that at least a first approximation of ACL kinematics during single leg landings could have been made. For a thesis on ACL injuries, the omission of the ACL from the developed MSM is a major oversight.

- *Other issues from candidate's response document:*

    - *[Comment 19]* What does the candidate mean when he says that *"Kinematic data filtered at 6 Hz and force plate data at 25 Hz worked out well"* ?

    - *[Comments 7 & 28]* In these comments the student seemingly rejects the notion that Newton's Laws predict that landing impulse must increase with increases in vertical and horizontal jump distances. His arguments are [illegible] the fact that the body [illegible] but rather a multi-segmented system. However, he is incorrect if he thinks that

Newton's Laws somehow do not hold in this situation. The impulse - momentum law states that $Ft = \Delta mv$, and in this landing situation the GRF vector represents the force F applied for time t to the body mass m. This force therefore acts to change the body's COM velocity v. With increases in height and distance, the initial velocity of the COM upon landing will also increase. During the landing phase, this initial velocity must be reduced to zero for successful completion of the landing. Because Δmv will therefore increase with height and distance, so must the impulse Ft. What the landing athlete can do is change their body motion upon landing to change the shape of the resulting Force-time curve, but the area under the curve (impulse) will remain constant no matter what landing strategy they adopt. With proper landing technique the athlete can perhaps prevent the peak force from increasing over a small range of height or distance increases, but the athlete can do nothing to prevent the impulse from increasing. I hope that the student's comments reflect nothing more than confusion concerning impulse *versus* peak force changes as height and distance increase.

Understanding of the subject matter: The candidate seems to understand the subject matter, as the review papers 1 and 2 display good knowledge of the extant literature concerning ACL injury. He has also chosen an important topic to study.

Contribution of the thesis to advancing knowledge: Until the data issues in papers 3, 4 and 5 outlined in the **General Comments** are addressed, I am unsure how much this thesis contributes to advancing knowledge.

Research methodology: The motion capture, force measurement and EMG data collection techniques used by the author are well established in the biomechanics community, as are the use of rigid body inverse dynamics models and musculoskeletal models. As described in the **General Comments** section above, I have questions concerning the implementation of the musculoskeletal modeling and the selection of subjects in paper 5.

Analysis of results and value of conclusions: As described in the **General Comments** section above, I have concerns about the computation of metric values from the time series data in papers 3, 4, and 5. This makes it impossible to fully understand the results of the experiments, and therefore the value of the conclusions. In my opinion, there are incorrect interpretations of at least some of the data presented, leading to some incorrect conclusions.

Organization, writing style and presentation of material: The organization of the thesis is [illegible] experimental work. The writing style itself is fine, although I find in many [illegible] the author [illegible] previous [illegible]

Chapter 7 which was titled "Discussion" but in fact was a summary of the 5 papers given in serial form, followed by a section on possible future research. It was not a general discussion of the thesis findings, which would integrate the important aspects of the different papers in a manner not possible within the separate chapters themselves. I suggested that with its original content, Chapter 7 would be better titled as "Summary and Future Studies." The candidate chose to act on this suggestion by changing the title, rather than re-write the text of the chapter to include such an integrated discussion. So now there is a void: the lack of a general integrated discussion of how the findings of the papers relate to each other and the topic of ACL injuries. I am unsure whether the university and school require such a chapter or not.

Revisions considered necessary in order for thesis to be accepted: Please refer to the **General Comments** section above for issues that, in my assessment, should be addressed in some manner before the manuscript can be accepted. Comments on more specific issues are listed below.

Specific Comments

1. Page 95 Why was the integration time for knee joint work set to be from 0.8 s before VGRF to 0.6 s after VGRF? Why not start when the GRF data indicated initial foot contact?

2. Page 95 Why didn't you calculate ankle and hip power and work too? This would allow you to better assess how the athletes changed their landing strategy with changes in height and distance.

3. Page 96 The time history figures should be presented first, before the metric data that was selected from specific points of these curves.

4. Page 98 In Table 1, shouldn't the peak HGRF (PGRF?) be negative? See Figure 4.

5. Page 99 Table 2 is very confusing. Only the r values for peak VGRF are given, although others are reported in the text. What do the brackets with * mean?

6. Page 100 In Table 3, shouldn't the peak HGRF (PGRF?) be negative? See Figure 4.

7. Page 101 Table 4 is very confusing. Only the r values for peak PGRF are given, although others are reported in the text. What do the brackets with * mean?

8. Page 106 In the first paragraph you state that single-leg landing data should not be compared to double-leg data, yet that is exactly what you do on page 107 with the Devita and Skelly study.

9. Page 105 - 108 Nowhere in the Discussion of paper 3 do you discuss the differences between vertical height and horizontal distance landing strategies, even though in your introduction you speculate that there may be important differences that could influence ACL injury related variables.

10. Page 115 Why did you hypothesize [illegible] would have no significant effect on kinematics, kinetics and knee energetics? This [illegible] opposite your view in the

previous chapter, and on page 114 you argue that increasing peak PGRF should affect knee response, and peak PGRF clearly increased with horizontal distance in the previous chapter (Table 3, page 100).

11. Page 119 Why are the PGRF curves in Figure 1b so different than the PGRF curves in the previous paper (Figure 4, page 102)?

12. Page 120 You state that *"Females had significantly smaller ankle flexion angles than males (see Figures 2a and 2b)."* However, these figures show that the females had greater plantar flexion angles (negative) than the males at the time of peak VGRF, not smaller.

13. Page 126 The descriptive statistics should be presented before the stats tables that reports significant differences.

14. Page 127 The peak PGRF data values in Table 3 are too small compared to the data shown in Figure 1b (page 119) or reported in the previous paper (Table 1, page 98).

15. Page 128 The text concerning females landing with less plantar flexed ankles is wrong (see comment **12. Page 120** and Figures 2a and 2b).

16. Page 130 The statement near the bottom of the page that "Females plantar flexed less..." is incorrect (see comments **12. Page 120**, **15. Page 128**, and Figures 2a and 2b).

17. Page 139 Why did you hypothesize that females will land with relatively greater peak VGRFs compared to males? You did not find gender differences in peak VGRF in paper 4, and these are a subset of those same data.

18. Page 150 In Figure 5, why is the x axis from 60 to 100 in normalized time? When did time 0 occur? When did time 100 occur? With the GRF data deviating from zero at ~90, it seems that most of the normalized time was well before landing.

19. Page 150 In Figure 5, why is the PGRF data positive?

20. Page 152 In Table 3, why are the ankle, knee and hip angles so different than in papers 3 and 4? Was a different angle convention used? If so, why?

THESIS EXAMINER'S REPORT FORMS

FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES

FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

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Canada's university

THESIS EXAMINER'S REPORT

Version française : *Rapport d'évaluation pour une thèse*

NAME OF STUDENT	STUDENT NUMBER	DOCTORAL THESIS ☐	MASTER'S THESIS ☐
DEGREE	ACADEMIC UNIT		
TITLE OF THESIS			
NAME OF THESIS SUPERVISOR	NAME OF THESIS CO-SUPERVISOR		
NAME OF EXAMINER	DEADLINE FOR SUBMISSION OF REPORT		

INSTRUCTIONS FOR EXAMINERS

PART A: EVALUATION / Tick off the choice that best describes your evaluation of the thesis.
PART B: COMMENTS / Provide your comments for each of the topics listed.
PART C: RECOMMENDATION FOR A PRIZE / Indicate your decision and complete the attached form if recommending thesis for a prize.
PART D: SIGNATURE / Sign and date the form.
PART E: DOCUMENTS / Return necessary documents.

PART A: EVALUATION

CRITERIA

DOCTORAL THESIS: THE THESIS must constitute a significant contribution to knowledge, embody the results of original investigation and analysis by the student and be of such quality as to merit publication.

MASTER'S THESIS: THE THESIS should demonstrate that the candidate is able to work in a scholarly manner and is acquainted with the principal works published on the subject of the thesis. Insofar as it is possible, the thesis should be an original contribution.

VERDICT

1	☐	**The thesis <u>is accepted</u> for the defence.** • The thesis meets the evaluation criteria listed above. • Required changes are limited to correcting occasional grammatical or spelling errors, formatting problems or to minor redundancies or omissions (e.g., transitional paragraphs, notes).
2	☐	**The thesis <u>is accepted</u> for the defence but must be revised <u>AFTER DEFENCE</u>.** • The quality of the presentation is acceptable, and the necessary revisions will not have an impact on the defence. • During the defence, the jury will determine which revisions are necessary and who will be responsible for ensuring they have been completed and for approving the thesis.
3	☐	**The thesis <u>cannot be accepted for the defence</u> and must undergo extensive revision <u>BEFORE DEFENCE</u> to ensure it meets the above criteria.** • There are problems with the interpretation of results or the theoretical or methodological approach, but the thesis may meet the criteria if substantial changes are made. • The presentation of the thesis is not acceptable (numerous grammatical or spelling errors, evidence of carelessness, etc.). In this case, the thesis is returned to the candidate to complete the required revisions, corrections and changes. The candidate must submit a revised version of the thesis to the examiners. The examiners must judge the changes satisfactory before the thesis can proceed to the defence stage.
4	☐	**The thesis <u>fails to meet the standards required</u> for the degree.** • The work was not done in accordance with established methodology employed by the discipline. • The thesis does not exhibit the candidate's capacity to meet the scholarly standards required. • Even with extensive revision, the thesis would not meet the standards required for the degree. In this case, the candidate may be asked to withdraw from the program.

NOTE: Your feedback will have an impact on how the candidate prepares for the defence, the dean's decision if the jury is divided and the awarding of prizes. Please be sure to complete Section B <u>regardless</u> of your verdict.

PART B: COMMENTS

Please provide your comments on each of the topics below in a separate document. If the thesis is accepted for the defence (see verdicts # 1 and # 2, above), your comments will be sent to the candidate and the thesis supervisor without reference to your identity. If major revisions are required before the defence (see verdict # 3, above), a signed copy of your comments will be provided to the student, the supervisor, as well as to all members of the jury and the chair of the academic unit.

→ UNDERSTANDING OF THE SUBJECT MATTER
→ CONTRIBUTION OF THE THESIS TO ADVANCING KNOWLEDGE
→ RESEARCH METHODOLOGY
→ ANALYSIS OF RESULTS AND VALUE OF CONCLUSIONS
→ ORGANIZATION, WRITING STYLE AND PRESENTATION OF MATERIAL
→ REVISIONS CONSIDERED NECESSARY IN ORDER FOR THESIS TO BE ACCEPTED
→ GENERAL COMMENTS

Your comments and explanations are extremely important and will:

- help the student prepare for the defence or make necessary revisions to the thesis (if revisions are required before the defence, a **signed copy** of your comments is provided to the candidate, the thesis supervisor, as well as to all members of the jury and the chair of the academic unit);
- allow the dean of FGPS to make an informed decision if the jury is divided; and
- allow the FGPS selection committee to choose recipients of prizes and medals.

PART C: RECOMMENDATION FOR A PRIZE

DO YOU RECOMMEND THIS THESIS FOR A PRIZE?

(   ) YES – Please complete the attached NOMINATION FOR THESIS PRIZE form.
(   ) NO

The absence of a reply will be considered a NO.

PART D: SIGNATURE

DATE ------------------------------------ SIGNATURE --

PART E: DOCUMENTS

DOCTORAL THESIS

Please return all documents by email to thesis@uOttawa.ca or by fax to 613-562-5992 and send the originals in the enclosed self-addressed envelope to:

Thesis Sector
FGPS
Hagen Hall
115 Séraphin-Marion, Room 107
Ottawa ON K1N 6N5

MASTER'S THESIS

Please return all documents by email to thesis@uOttawa.ca or by fax to 613-562-5992 and send the originals in the enclosed envelope to your academic unit.

FACULTÉ DES ÉTUDES SUPÉRIEURES ET POSTDOCTORALES

THESIS EXAMINER'S REPORT FOR A REVISED THESIS

uOttawa

L'Université canadienne
Canada's university

FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

Version française : *Rapport d'évaluation pour une thèse remaniée*

NAME OF STUDENT	STUDENT NUMBER	DOCTORAL THESIS ☐	MASTER'S THESIS ☐
DEGREE		ACADEMIC UNIT	
TITLE OF THESIS			
NAME OF THESIS SUPERVISOR		NAME OF THESIS CO-SUPERVISOR	
NAME OF EXAMINER		DEADLINE FOR SUBMISSION OF REPORT	

INSTRUCTIONS FOR EXAMINERS

PART A: EVALUATION / Tick off the choice that best describes your evaluation of the revised thesis.
PART B: COMMENTS / Provide your comments for each of the topics listed.
PART C: RECOMMENDATION FOR A PRIZE / Indicate your decision and complete the attached form if recommending thesis for a prize.
PART D: SIGNATURE / Sign and date the form
PART E: DOCUMENTS / Return necessary documents.

PART A: EVALUATION

CRITERIA

DOCTORAL THESIS: THE THESIS must constitute a significant contribution to knowledge, embody the results of original investigation and analysis by the student and be of such quality as to merit publication.

MASTER'S THESIS: THE THESIS should demonstrate that the candidate is able to work in a scholarly manner and is acquainted with the principal works published on the subject of the thesis. Insofar as it is possible, the thesis should be an original contribution.

VERDICT

1	☐	**The revised thesis is accepted for the defence.** • The revised thesis meets the evaluation criteria listed above. • Required changes are limited to correcting occasional grammatical or spelling errors, formatting problems or to minor redundancies or omissions (e.g., transitional paragraphs, notes).
2	☐	**The revised thesis is accepted for the defence but additional changes are required AFTER DEFENCE.** • The quality of the presentation is acceptable and the necessary changes will not have an impact on the defence. • During the defence, the jury will determine which additional changes are necessary and who will be responsible for ensuring they have been completed and for approving the thesis.
3	☐	**The revised thesis still cannot be accepted for the defence and must undergo additional extensive revision BEFORE DEFENCE to ensure it meets the above criteria.** • There are still problems with the interpretation of results or the theoretical or methodological approach, but the thesis may meet the criteria if substantial changes are made. • The presentation of the revised thesis is still not acceptable (numerous grammatical or spelling errors, evidence of carelessness, etc.). In this case, the revised thesis is returned to the candidate to complete additional revisions, corrections and changes. The candidate must submit a new revised version of the thesis to the examiners. The examiners must judge the changes satisfactory before the thesis can proceed to the defence stage. **If more than one examiner chooses this verdict for the revised thesis, the student must withdraw from the program.**
4	☐	**The revised thesis still fails to meet the standards required for the degree.** • The work was not done in accordance with established methodology employed in the discipline. • The thesis still does not exhibit the candidate's capacity to meet the scholarly standards required. • Even with additional extensive revision, the thesis would not meet the standards required for the degree. **By choosing this verdict, the examiner recommends the student withdraw from the program. If more than one examiner chooses this verdict for the revised thesis, the student must withdraw from the program.**

NOTE: Your feedback will have an impact on how the candidate prepares for the defence, the dean's decision if the jury is divided and the awarding of prizes. Please be sure to complete Section B regardless of your verdict.

PART B: COMMENTS

Please provide your comments on each of the topics below in a separate document. If the thesis is accepted for the defence (see verdicts # 1 and # 2, above), your comments will be sent to the candidate and the thesis supervisor without reference to your identity. If major revisions are required before the defence (see verdict # 3, above), a signed copy of your comments will be provided to the student, the supervisor, as well as to all members of the jury and the chair of the academic unit.

→ UNDERSTANDING OF THE SUBJECT MATTER
→ CONTRIBUTION OF THE THESIS TO ADVANCING KNOWLEDGE
→ RESEARCH METHODOLOGY
→ ANALYSIS OF RESULTS AND VALUE OF CONCLUSIONS
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→ REVISIONS CONSIDERED NECESSARY IN ORDER FOR THESIS TO BE ACCEPTED
→ GENERAL COMMENTS

Your comments and explanations are extremely important and will:

- help the student prepare for the defence or make necessary revisions to the thesis (if revisions are required before the defence, a **signed copy** of your comments is provided to the candidate, the thesis supervisor, as well as to all members of the jury and the chair of the academic unit);
- allow the dean of FGPS to make an informed decision if the jury is divided; and
- allow the FGPS selection committee to choose recipients of prizes and medals.

PART C: RECOMMENDATION FOR A PRIZE

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( ) YES – Please complete the attached NOMINATION FOR THESIS PRIZE form.
( ) NO

The absence of a reply will be considered a NO.

PART D: SIGNATURE

DATE ------------------------------ SIGNATURE --

PART E: DOCUMENTS

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FGPS
Hagen Hall
115 Séraphin-Marion, Room 107
Ottawa ON K1N 6N5

MASTER'S THESIS

Please return all documents by email to thesis@uOttawa.ca or by fax to 613-562-5992 and send the originals in the enclosed envelope to your academic unit.

FIRST VERSION OF COMMENTS FROM STUDENT IN RESPONSE TO EXAMINERS' REPORTS

V 1

PhD THESIS REVIEW SHEET for Examiner A	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali, Dr. Gordon Robertson, Dr. Gholamreza Rouhi	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

Examiner A

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
1	<u>The thesis does not constitute a significant contribution to knowledge and the analysis by the student is not of such quality as to merit publication.</u> · Note: although 2 literature reviews are published, neither is in a journal particularly related to the subject matter presented. Neither describes the methodology used to decide on the chosen articles. Neither uses any criterion to evaluate the included articles. As reviews of literature, they are not significant contributions. · I would not consider the final three manuscripts (III, IV and V) merit publication due to, among other things described	Many thanks for your feedback. For a graduate student to publish a review paper is a significant accomplishment and demonstrates a sound understanding of the literature. Typically only renowned researchers established in a field publishes reviews of the literature. We'd like to ask this respected reviewer whether the journal where one publishes his/her work can determine the scientific merit of the work?. We firmly believe that from this reviewer's comment here about our review papers, one can not raise the doubt about the scientific merit of our review papers. Moreover, the first journal is fully devoted to the field of biomechanics, as opposed to this respected reviewer's point, stating that neither of our first 2 papers is published in a journal related to our subject matter. The methodology to selected papers are included in both reviews and clearly stated in the page 31 of the thesis for paper 1 and page . Can you please provide the scholarly journals that stipulates the number of subjects that must be included in a study to warrant consideration for publication- we will be

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	further on, methodological concerns such as a lack of sufficient subjects (manuscripts III, IV, V). Paper V also lacks model validation (although it is stated many times in the thesis that this has been done) and uses a male musculoskeletal model to represent females (it is simply a scaled down size of model, as pointed out to me by the co-authors on the paper). To my knowledge, this paper has also been rejected outright by the journal it was submitted to, although it is still referred to as submitted in the thesis.	very thankful if you do so. Can you please let us know what scientific data have you used to establish there was a lack of subjects?. As we all know biomechanics is a field with an empirical tradition. This means that reviewers tend to accept experimental data with many subjects with less criticism. Experimental data showing significant differences are also usually accepted, although they do not provide any causality for the observed differences. On the other hand, analytical insights providing causality is rarely accepted unless it is backed up by significant experimental data. In mechanics the tradition is exactly opposite. In mechanics you will have a hard time getting anything accepted in the absence of a model explaining the observed differences. From this perspective we understand your position, but ask you to recognize the progression and contribution of this thesis in moving from gap studies, to identifying unfocused questions, to using a rigid body model in Visual3D to answer these questions scientifically, to development of a MSM in AnyBody to provide more refined answers. For example, the greater muscle and joint reaction forces observed in this study over increasing heights and distances, which has never been reported in the literature before, and it seems interesting and should assist in better explaining risk of injury compared to results provided by rigid body models in Visual 3D. We would like to raise the following question for this reviewer: can one conclude just based on the decision made on a submitted manuscript, either acceptance or rejection, that it's flawless or flawful?. We also like to see if one can simply discard all efforts put in, and all positive aspects and impacts of a work/manuscript, just because of being rejected (sometimes because of very sharp and knowledgeable and/or ignorant reviewers). Frankly speaking, this respected reviewer's way of commenting on our thesis/papers clearly shows that if a manuscript submitted to a journal was rejected then there is nothing positive and appreciable in that work, which does not seem to be fair at all. The limitations of the MSM developed are not a limitation of this thesis, but a limitation of science. The MSM modeled developed for application to single leg landing is the first of its kind in the scientific community. How are musculoskeletal (MSM) models validated in the literature?. To the best of our knowledge, the gold

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
		standard now to validate a MSM is to compare measured and predicted muscle activity as done in the thesis. Please educate us if you have any other methods to validate the MSM model. However, to gain greater confidence in the model, we did many other things. One that is worth reporting in a scholarly publication is the comparison of model predictions to *in-vivo* data in the literature. To facilitate this comparison the researcher used *in-vivo* studies where body weight and anthropometry of subjects were much higher than those used in the thesis and can likely explain why some of the joint reaction forces do not compare well. To date the data referenced by the authors are the only data available in the scientific community, of course to the best of our knowledge- please educate us if we are ignorant in this regard. So one may argue that when *in-vivo* data from weighted-matched subjects become available, our results should compare much better with model predictions. The term subject specific was removed from the paper and term "individualized" was used as suggested by the co-authors of the paper. Please see revised paper. You are correct that a male MSM model was used. What evidence exists that supports anatomical differences between genders and is accepted by the scientific community as a risk factor explaining the disparity in injury rate between genders and further warrant inclusion in a model? No such evidence or consensus exists-educate us please if you have new evidence. Further, cost benefit tradeoff of developing a female MSM was not justified. For your awareness, in paper 3 and paper 4 a rigid body model was used (see Attachment B). This model uses classical inverse dynamics analysis and inertial properties that are by no means that of any of the subjects tested. Further, this model uses cylinders, frustas, and ovoids to represent body segment as shown in Attachment B. Why is this model accepted with no validity and less scrutiny than that in Paper 5. See attachment C for what the validated model in paper 5 looks like. What about the validity of the data in paper 3 and paper 4 given the use of model in Attachment B? So how valid are these data given we have assumed the body is an n-linked system of rigid geometries solids? Which model would you say is more representative and accurate: attachment B or attachment C? Given these questions we are intrigued by your comments. We believe the limitations you have highlighted

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
		are obvious to most in science and easy for anyone to attack and are by no means a limitation of this thesis, but a limitation of the current state of science itself. The last statement puts into question the integrity of the student. This is troubling. The paper was submitted and under review at the Annals of Biomedical Engineering before the thesis was submitted. **The paper was NOT rejected outright but was thoroughly reviewed by three reviewers at ABE and deemed unworthy for acceptance. The scientific rationalization for not accepting this paper was provided by all three reviewers.** **Your review of the thesis questions the competencies of the supervisor, the co-supervisor and the thesis committee members who are responsible to guide the student.** The respected reviewer should note that this thesis, also our accepted/submitted papers are the result of numerous serious and challenging work of a number of researchers, including the student. It does not seem to be fair to simply discard all these efforts, just by happily (?!) looking at the **outright rejection** (?!) of a submitted manuscript. We thank you for your views but **your comments address shortcomings that do not aid improvement to the student's work.** **Constructive criticism should not attack the student's integrity nor that of the PhD program at the School of Human Kinetics.** We ask for an objective review of the thesis one that another examiner may be able to provide should you not be willing to revise.
2	1. The work was not done in accordance with established methodology employed by the discipline. (below is a non-exhaustive overview of some of my concerns)	Thank you for your comments.

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	· Results of the experimental manuscripts are inconclusive and not valid due to lack of sufficient subjects in all three manuscripts. No power analysis was reported but, based on my experience in the discipline, at least 2 to 3 times the number of subjects are required in manuscripts III and IV, likely more would be required for paper V.	Can you please let us know what is the number of subjects that would make this study conclusive and valid?. In testing using humans wouldn't it be contentious to conclude anything with a population of less than 1000 subjects?. What sample size makes a study conclusive and valid?. What data have you used to determine sample size is small? Paper 5 is a modeling effort and experimental data are used to validate and drive the model. We yet to see a MSM study within the domain of ACL injury biomechanics with over 6 subjects. Please educate us if this is because of our lack of knowledge.
	· The paper V purports to evaluate gender differences using musculoskeletal models, however (for example), only three subjects of each gender are evaluated and the model used on both genders is in fact a male model...in other words, the females are in fact treated as height and weight adjusted males. The claim in the manuscript that the model has been validated is not supported by the results.	Please see comment above as this comment is repeated. Do you believe a rigid body MSM of the female subject is worth the cost of development?. For example the development of the MSM model used for this study took over 10 years of research and many PhDs and an enormous amount of money. What features of the females you believe are not captured in the existing MSM that you feel are important and please let us know why?.
	· Although the use of a repeated measures ANOVA is questionable in all three experimental manuscripts due to the number of subjects evaluated, it is particularly dubious in paper V where only three subjects are in each group, not to mention that no correction for related	Please let us exactly know what aspect of the analysis is questionable?. Is there a limitation on N to which ANOVAs can be applied?. What values from the ANOVA analysis did you use to formulate/raise this question? All the ANOVAs analysis is accurate and does indeed show that we have more subjects than we actually need. From the ANOVA studies conducted, the high F values indicate that we have more subjects that we really need. In fact, for paper 3, we could have easily used 3 subjects and get high F statistics and powers. From work of Cohen 1988, the acceptable powers are above 0.8. There are many studies in the literature where powers below 0.5 are published. However, your point may be valid for PPMC even though data reported does not substantiate your comment here as well. Recall Pearson correlation is not a robust analytical tool as are ANOVAs. For Pearson correlations, we are trying to develop a regression equation to enable us to make predictions to any other conditions and for

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	measures is considered, nor is the post-hoc analysis described. · The external validity of manuscripts III and IV is limited, as stated by the authors themselves. · The internal and external validity of paper V are limited.	any subject. It is harder to get high coefficient of determinations with such small population size and because we had to limit the number of jump heights and distances. Nonetheless, our data do not entirely show this. Our data do reveal significant findings for PPMCs for studies conducted. Given this why more subjects are required?- please educate us. Paper 5 is a musculoskeletal modeling effort and not experimental effort whose purpose was to develop, validate and apply the models to experimental data to get the internal forces. We are still to see a MSM study applied to non-contact ACL injury mechanics that employ more than 6 subjects.
3	2. <u>The thesis does not exhibit the candidate's capacity to meet the scholarly standards required. (below is a non-exhaustive overview of some of my concerns)</u>	**Thanks for your comments. If the FGPS kindly agrees, this concern will be addressed at the thesis defense.** **Your review of the thesis questions the competencies of the supervisor, the co-supervisor and the thesis committee members who are responsible to guide the**

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
		student. We thank you for your views but your comments address shortcomings that do not aid improvement to the student's work. Constructive criticism should not attack the student's integrity nor that of the PhD program at the School of Human Kinetics. We ask for an objective review of the thesis one that another examiner may be able to provide should you not be willing to revise.
	· The methodological concerns noted above indicate that the candidate lacks the scholarly standards from a technical (methodological) point of view.	. Will address at the thesis defense.
	· Information contained in the thesis in misleading since at least two of the declared conference presentations were never presented.	**What is the relevance of this comment to the technical evaluation of this thesis?- we can not understand- please educate us. How are did you become aware that two conferences were unattended by the student. Aren't there justifiable reasons why a student does not attend a conference?. Are you aware of these?**
	· Letters from the editors of the journals with manuscripts Under Review are not provided. This is an essential first step since, to my knowledge, at least one of those manuscripts has in fact been rejected outright and this is not noted in the thesis.	Comment is repeated. This comment only puts the integrity of the student into question.
	· The two accepted manuscripts are reviews of literature in journals that are not reflective of the article content and, although accepted, are of limited value due to a less than rigorous or exhaustive	.Comment is repeated. Biomechanics is a very multidisciplinary field and will arguable only continue to progress with increased synergy between disciplines. Further, for your awareness the root of the word biomechanics speaks multidisciplinary as it stems from the application of engineering mechanics to a

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	methodology which is not coherent with systematic reviews. · Manuscripts IV-V lack statistical power, adequate methodological descriptions, and inappropriate use of statistical measures. · The student repeatedly states in this thesis that a lack of multifactoral research exists in the study of ACL injuries yet many of the studies sited are multifactoral in their approaches, in particular those that combine kinematics and kinetics or musculoskeletal models... the student seems to dismiss these in order to justify this thesis, instead of acknowledging what has been done and how it contributes to the field of study and does not seem objective. Then, in the end, the study uses similar methodologies to form his conclusions as the papers previously criticised	living body. Comment is repeated again. We would be interested to know how you established this. See response above. .Please consult figure 2 in both paper 1 and paper 2 to better understand what the authors envision by the multifactorial approach proposed. The mutlifactorial approach presented is one that uses AI to combine all 5 exiting study approaches in a single unified environment. To date such an approach does not exist in the literature. Further, this type of approach is where research groups are leading towards.
4	3. <u>Even with extensive revision, the thesis would not meet the standards required for the degree.</u> · As a body of work there are too few subjects, weak methodological and statistical approaches and overreaching	. This will be addressed at the thesis defense.

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	conclusions beyond the evidence suggested by the results in all three experimental papers. · The two published manuscripts are of limited contribution and published in journals which are not discipline-related.	
5	The candidate states: *"To the best of the author's knowledge no study to date has investigated gender differences during single-leg landing from increasing vertical landing heights and horizontal landing distances."* Meanwhile, there exists a great body of knowledge about the biomechanics and associated risk factors of single leg landing under various experimental and simulated conditions, including vertical landing heights, for example.	Thanks for the feedback. It would have been constructive and beneficial to the student if you provided this "great body of knowledge about the biomechanics and associated risk factors of single leg landing" you speak of.
6	*"Further, there are no MSMs in the scholarly literature that has been developed, validated and applied to single-leg landing in the literature."* Untrue, there are... not to mention that the student does not fill this purported void with the thesis.	Thanks for the feedback. If such work exists it would have been constructive and beneficial to state them. Please educate us.
7	*"Further, the majority of studies in the literature pertaining to single-leg landing*	Thanks for the feedback. If such work exists it would have been constructive and beneficial to state them. Please educate us.

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	do not account for the effects of whole body movement on ACL loading." Untrue, there are... not to mention that the student does not fill this purported void with the thesis.	
8	*"In addition, to the author's best knowledge, the current literature demonstrates that there are no proposed multifactorial study approaches aimed at fusing existing non-contact ACL injury study approaches into a single environment using an AI technique."* This statement is unclear since it is unclear what the author is referring to as an AI environment. Two thing are certain: (1) many studies have used multifactorial models and approaches to investigate non-contact ACL injuries; (2) if the candidate refers to the approach he has taken in Paper-V, then it is again untrue and others have done this before, whereas if he is referring to some new innovative approach, the candidate has not done it in this body of work nor elucidated what that approach would be.	This is an article style thesis. Please provide a study within the domain of ACL injury biomechanics that proposes a study methodology as done in Figure 2 of paper 2. As elucidated in paper 2, there are many AI techniques. The application of a technique to fuse existing ACL injury study approaches in a single environment is novel, we think. A starting point of how to do this can be found in Figure 2 of paper 2. Please consult Attachment A from a renowned researcher in the field of ACL injury biomechanics after reviewing Paper 1 which presents the same method as in paper 2 but with improvements. Keep in mind the date the papers published by this research group in AJSM and JOB are after Paper 1. Further the statement you quoted above has to do with the "fusion of existing non-contact ACL injury study approaches into a single-environment using an AI technique" which your two points have no bearing on.
9	*"These models are driven by kinematics and external forces."* The candidate is speaking of musculoskeletal models but fails to recognise the body of literature which uses EMG driven models, which are in fact driven by internal forces, as muscles are internal force generators to the system.	The author has referenced in paper 5 studies that use EMG driven musculoskeletal models applied to study ACL injury biomechanics (please see Dr. Lloyd's research group work that was referenced).

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
10	Very limited since the validity of the studies (both internal and external) is questionable. In particular, a lack of subjects make the results highly speculative and the statistical approaches inappropriate. There is little innovation aside from modifying jump height and distance, and the two reviews of literature are not exhaustive or systematic and seem biased.	This comment is repeated yet again. Thank you for your comments. This will be addressed at the thesis defense. **Respectfully, your comments are similar yet repetitive throughout, subjective, and non-scientific to enable one to formulate a scientific answer.**
11	It must also be stated here that paper V uses commercially available software (ANYBODY) to build the model and analyse the data, not a custom model developed by the student. This is not clear in the thesis.	See section titled "Model development and validation" of paper 5 where your concerns were addressed. We taken a model out of the repository and individualized it to each subject as mentioned many times in the paper.
12	Paper 1: . The methodology described for the initial review of the literature seems initially exhaustive, however when I used one of the 4 search terms provided by the authors I turned up 3743 articles whereas the authors found 813 articles total; furthermore no criterion for triage down to the 147 articles cited is given by the authors. Considering the strong focus on modeling in the paper, at least one search term should include the word model or simulation, for example.	Thanks for the feedback. It was not the intention of this work to gravitate towards any particular ACL injury study approach, we presented what we found. If there is a lending to any one study approach this may be a reflection of preference of methods employed in the literature. .Finally we reviewed the most significant 813 articles.

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
13	Paper 1: . One example of a lack of depth to the discussion: *"Mathematical programming and the Monte Carlo method (Blankevoort and Huiskes, 1996; McLean et al., 2003) are the current often used optimization approaches employed to study ACL mechanics. Although both mathematical programming and Monte Carlo methods have demonstrated their usefulness and effectiveness as a research tool, there are much more advanced and robust AI techniques; namely, taboo search, simulated annealing, genetic algorithms, and artificial neural networks."* In fact, "simulated annealing" is currently one of the most popular and widespread methods in musculoskeletal modeling...	The focus of paper 1 and paper 2 is in the domain of ACL injury biomechanics and overcoming existing barriers to our understanding of the mechanisms and risk factors to ACL injury and not to the entire domain of biomechanics or musculoskeletal modeling. We do accept in the paper that simulated annealing has been applied to ACL injury study by one research group. Outside of this research group, please provide references of how simulated annealing has been applied to ACL injury biomechanics. **Further, our work is in the application of AI, and the novelty stretches to how this method is applied to tie together these disjointed disciplines into a unified environment to allow one to more comprehensively study ACL injury mechanics especially given the limitations one encounters when one employs an existing ACL injury study approach on its own**. Further paper 1 and paper 2 are focused on the domain of ACL injury biomechanics and NOT the entire field of biomechanics. If we are to consider the entire field of biomechanics, then your claim may be accurate. At the time of writing this paper, to the authors' best knowledge, the only application – referenced in the thesis- of an AI technique to ACL injury biomechanics was by McLean et al (Clin Biomech. 2004 and 2008). In the earlier paper (Mclean et al. 2004) only the word simulated annealing (SA) is mentioned. How the technique is applied to this study is not provided. Regardless, the authors use SA to minimize the difference (errors) between predicted and baseline muscle simulation data. Minimizing the difference in errors using an iterative search technique is common in mathematics and has nothing to do with the study methodology proposed in paper 1 and paper 2. A later study Mclean (2008) provided more details into the application of SA to ACL injury risk prediction. However the application of this technique to this study is exactly the same as mentioned above and therefore is not as what is proposed in paper 1 or paper 2. Further one would not be able to use this study to implement their own SA method given problem in McLean et al.'s 2008 paper is ill defined. In this study, the authors mention the objective function and variables, but no constraints or constraints approach. Further, the authors use a fixed number of iterations as opposed to terminating the program against some test of optimality. Nonetheless, given this

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		paper applies SA to minimize errors between predicted and baseline muscle simulation data, it has no relevance to work presented in our 1st and 2nd papers. **In this vain, we ask that you highlight to us and educate us the use of AI technique to the field of ACL injury biomechanics.** **Paper's 1 the novelty is not in AI or OR techniques that have been exiting for many decades but in the application and how to apply an AI technique to address the barriers to our understanding of non-contact ACL injury mechanics.** Paper 1 presents a way using AI to fuse existing ACL injury study approaches into a single unified environment to better understand how and why the ACL gets injured. **We would like to request this respected reviewer to help and provide us a research paper that presents a paradigm that uses AI to fuse existing study approaches into a single environment with the objective to predict ACL injury.** **Paper 2 provides more details, awareness, and possible techniques from AI and OR communities that may be utilized in ACL injury research.** Again here the paper is focused on application of AI and OR to the study of non-contact ACL injury biomechanics, but not the entire field of biomechanics. What is exciting about paper 2 is the research community is slowly beginning to realize that new research methodologies are required to understand ACL injury mechanics. These new approaches perhaps need to borrow from each approach given that an approach on its own is limited in its ability to fully capture factors implemented to increase the likelihood of ACL injuries. So the question then is how can we capitalize on the strengths of existing study approaches, so we can more comprehensively and completely capture the problem of ACL injury mechanics. One possible tool to do this is optimization, more specifically AI. The authors also present a more refined way to do this in the paper 2. **You are correct that AI was applied to the field of biomechanics for decades, but not to non-contact ACL injury biomechanics which is the focus of this thesis and both papers 1 and 2.**
14	Paper II: It is not quite clear if this paper is a review	Comment repeated yet again. See response above.

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	of literature or opinion-piece on how to investigate ACL injury. To me, it is more of an opinion piece and is more suited to be in a thesis discussion then as a publication since it lacks objectivity.	
15	Paper II: .It is not clear why the authors would chose this journal as it does not seem to be related to the field being investigated.	Comment repeated yet again. See response above.
16	Paper II: Similar concerns with regards to the approach and criterion used to select papers as paper 1 above.	Comment repeated yet again. See response above.
17	Paper II: This paper would serve as an introduction to the thesis, but in my opinion is not an in depth review.	Comment repeated yet again. See response above.
18	*Note that while I believe it is a good idea to try and publish one's thesis, papers one and two seem to be the review of literature portion of the thesis as opposed to original scientific contributions to the literature.*	Paper 1 and paper 2 are published. Please be aware that this is an article style thesis. Further, publication of review of the literature by a student is not a trivial task, such review are usually delegated to reputable researchers with many years of experience in the field. Given this, be aware please that publication of both papers as separate pieces of work with their own objectives, methods and outputs was a challenge.
19	Manuscripts III and IV: · There is a lack of subjects, putting the statistical analysis and validity in	Comment repeated yet again. What part of the statistical analysis you have doubt about?- please clearly let us know. We are eager to address your concern in this regard.

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	doubt. I believe that this statement by the authors is worth noting *"this study is limited by a small sample size; hence our results may not be representative of the general population and may not be conclusive. While we cannot conclude the general male population would exhibit sagittal plane body kinematics, knee power, and knee work as determine in our study for single-leg landings, we were able to show that the relationships found have a good fit in terms of r2 and p values for the six subjects tested."* The r-square and p values are questionable since there were not enough subjects to perform these tests in the first place...as a PhD thesis, this is unacceptable. These two manuscripts are better described as pilot projects or incomplete projects.	What aspect of the statistical analysis is invalid?. **A lack of subjects cannot put the "statistical analysis and validity of a study in doubt", but it can potentially "unpower" a study, we believe.** It is a standard practice for biomechanics journals to present a limitations section in the paper as we have done throughout this thesis. The question then is what makes a study conclusive and valid in biomechanics?. Would a hundred subjects suffice or five?. How does one establish this?, and would this make the study conclusive?. We provided F statistics and the *eta* squared values in all papers. We added observed powers to some of the papers as well. Please note given the data reported in many cases a smaller subject population would suffice for the ANOVA analysis, but for the correlation analysis, as it is always the case, a large subject population is best. This is the case because we are conducting a regression study, but had to limit the number of jump heights and distances.
20	Manuscripts III and IV: . Even if one considers the correlation values reported, the relatively low levels of correlation make conclusions difficult to support (a statistically significant correlation does not necessarily mean an important one...)	Be aware that adding subjects to the pool does not necessary guarantee one an increase in correlation coefficients or powers given the variability to be expected when testing humans.
21	Manuscripts III and IV: . The emphasis in the two reviews of literature is to avoid a reductionist approach when studying the ACL injury,	This is true. Paper 1 and paper 2 are separate pieces of work. The lack of funds, resources, skill sets, and support has forced the candidate not to pursue the development of the methodology. The development of such a methodology requires a research group with software, computing capability, and disparate skill sets, which was and still is lacking. The new research paradigm proposed is something that is

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	yet these manuscripts do exactly that.	absent from the scholarly literature. Regardless, paper 1 and paper 2 are reviews of the literature that exposes many gaps in knowledge in the field of ACL injury biomechanics, steers future research direction, and provides a possible way to address these gaps is the new research methodology proposed. Hence the review of the literature does not center on this new proposed approach, but non-contact ACL injury.
22	Manuscripts III and IV: . It is unclear if the subjects from paper III were used in paper IV and this should be stated.	This has been amended to make clear in the thesis. This was never mentioned given this is an article style thesis.
23	Manuscripts III and IV: . A table containing the dependant variables is not clear *"various selected dependant variables"* is the only information given.	This has been amended to provide these tables.
24	Manuscripts III and IV: .No consideration of the inter-dependence of the selected variables is given and no correction of the probability coefficient is considered for these variables	The interdependences of various dependent variables on risk predictor is provided given the aim is to assess risk of injury. Further, the effect of an independent variable on selected dependent variables was provided. A sensitivity study may provide more information but this approach provides a limited view of the problem as mentioned in paper 1.
25	. Given paper IV, paper III seems redundant.	. Paper 4 builds on Paper 3 by adding the effect of gender and a much larger study population. As per paper 3 "Future studies by the authors will endeavor to employ a larger sample size as well as to account for the effect of gender during single-leg landings from varying heights and distances."
26	Manuscript V: ·Too few subjects (3 males and 3 females) to extract meaningful	Repeated comment. See comments above. Further, paper 5 is a modeling effort with the aim of developing, validating and then applying MSMs to single-leg landings. This type of study and the data reported are absent from the literature and hence is

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	conclusions. Similar to manuscripts III and IV, this manuscript is a good beginning, but not and end product.	deemed novel.
27	Manuscript V: . There is a lack of model validation: the authors somehow conclude that the musculoskeletal model is valid based on EMG activations which are not reflective of the predicted model-driven activations, with no objective comparisons...this makes no sense to me.	The on/off timing curve provides this objective comparison. Further to this, we have added average correlation coefficients for the 8 muscles measured with model predictions. As well, we have provided comparisons of *in-vivo* joint reaction forces and moments with model predictions to aid model validation. The limitations of the MSM are not a limitation of this thesis, but a limitation of science.
28	Manuscript V: .The model used in this paper is not novel nor is it developed by the candidate: it is an application of a musculoskeletal model from the ANYBODY Software repertoire, which requires the user of that model to adjust the model to the input data.	As was stated in the paper 5: "The development of a MSM from the ground up is a very time consuming and complex endeavor. To mitigate these challenges, the AnyBody research group has embraced a philosophy of creating a model repository and sharing it with the public. The GaitFullBody MSM was extracted from the repository and individualized for each subject." The model used for this study is the most heavily worked on and verified model in the AnyBody modeling repository hence its usage for this work. The development of such a model from the ground up is an enormous undertaking. Regardless, the co-authors of this paper can assure you that the modeling effort to get this model to work for application to single-leg landing was over six months of work with the software developers themselves (co-authors in this paper) in Denmark. The novelty is the application of the model to single-leg landing over increasing heights and distances which has never been reported in the literature. Further, a MSM investigating single-leg landings does not exist in the literature hence the novelity. To achieve stability for MSMs applied to high acceleration tasks such as for single-leg landings is no trivial task and has never before been conducted.
29	Manuscript V: .The model used for the female subjects is a scaled version of the male model, not a gender-specific model. As such, it cannot take into account physiological and	Comment is repeated again. Please note, the purpose of the paper is not to investigate anatomical differences.

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	anatomical differences between the sexes, even though the purpose of the paper is to evaluate these things.	
30	.The statistical analysis of the results is questionable due to the small sample sizes in all manuscripts	Comment repeated yet again. See comments above.
31	. The validity of the model used in paper V is not established; the use of a male musculoskeletal model to represent females is questionable, in particular given the anatomical and neuromuscular sex-related differences highlighted by the candidate, for example.	. You are right. However, what features in the female musculoskeletal model you deem are important and would warrant the development of a female MSM model? Please provide the scholarly evidence in the literature that shows consensus on difference in anatomical or neuromuscular factors between genders contributing to risk of ACL injury- we are eager to know and learn. .One may argue that there is no difference is lower extremity anatomy below the pelvis between genders; .One may also argue that it is simply not feasible to model the female vice male anatomy given this require undertaking MRIs, segmentation, digitization etc.
32	.The value of the conclusions was accurately put into doubt by the candidates own statements regarding a lack of sample size for manuscripts III and IV.	This comment is repeated many times. What sample size for an experimental study makes a study conclusive in the field of biomechanics? Further, how does one establish the validity of such conclusion?
33	.The value of the conclusions for paper V are in doubt due to a lack of sample size and the above mentioned lack of model validation and use of a male model to represent females.	This comment is repeated many times. See comment above.

PhD THESIS REVIEW SHEET for Examiner B	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali, Dr. Gordon Robertson, Dr. Gholamreza Rouhi	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

Examiner B

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1	. ***Lack of anatomical description of the knee structures and the role of the ACL within this overall structure*** - Given the thesis topic, early in the thesis it would be appropriate to include a detailed description of the knee anatomy and function, including clear diagrams of the ACL, its location, and its role within the complete milieu of ligaments, muscles, cartilage and bones that form the knee structure. This description (and accompanying diagrams) should make very clear why jumping from various heights and distances might be expected to cause ACL injuries, thereby helping to	. Thanks for the feedback. This is an "article style" thesis. Secondly I was instructed not to include this sort of information in the thesis by my supervisor. Finally, there was no guidance available at the School of Human Kinetics on how to prepare an article style thesis, format, content, sample etc. However, I have endeavored to add material to the introductory chapter to address your concerns.

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	build the rationale for the experimental work to follow.	
2	. ***Duplication of review of literature material in papers 1 and 2*** - Although I understand that papers 1 and 2 were written for separate publication in academic journals, there is much overlap between the 2 chapters. From the perspective of the thesis document, I think the review of literature would be much better served if written as a single chapter. The 2 submitted papers could be included as Appendix material.	. Thanks for the feedback. In paper 1, to rationalize why new research methodologies are required, the challenges to understanding the mechanisms and risk factors to non-contact ACL injuries are presented. Further, the authors proposed a possible methodology to address many of these challenges. For paper 2, the goal is to bring awareness of two optimization approaches, i.e. OR and AI. The authors provide rationalization of why AI is better suited of the two approaches to address the challenges of non-contact ACL injury. But, what are these challenges. These challenges as presented in paper 1 had to be repeated to make paper 2 all encompassing, a standalone document and complete. So in order to justify the use of an OR or AI technique, the authors first needed to tell the story about the problem. The problem is why we still do not know how and why non-contact ACL injury occurs. Hence, there are definitely repeats in the background information on the challenges to understanding non-contact ACL injury in papers 1 and 2. The authors presented tools available in the optimization world from both OR and AI communities that can possibly address these challenges. The authors went on to show why AI approaches may be appropriate to tackle the problem of how and why the ACL gets injured. This sort of proposed study methodology was absent from the literature, to the best of our knowledge.
3	***Possible lack of awareness concerning use of optimization techniques such as simulated annealing and genetic algorithms in the biomechanics literature*** - While reading the Introduction and paper 1, I was intrigued by the author's contention that present study approaches are inadequate and that he was proposing to use new state-of-the-art artificial intelligence	. Thanks for the feedback. Please note that paper 1 and paper 2 are focused on the domain of ACL injury biomechanics and NOT the entire field of biomechanics. If we are to consider the entire field of biomechanics your claim may be accurate. At the time of writing the 2^{nd} paper and to the author's best knowledge the only application – referenced in the thesis – of an AI technique to ACL injury biomechanics was by McLean et al. (Clin Biomech. 2004 and 2008). In the earlier paper (Mclean et al. 2004) only the word simulated annealing (SA) is mentioned. How the technique is applied to this study is not provided. Regardless, the authors use SA to minimize the difference

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	(AI) tools and techniques. However, much of the text was vague and lacking details. It was not until near the end of paper 1 (page 45) that I discovered that the AI tools include optimization techniques such as simulated annealing and genetic algorithms. Although the author may (or may not) be correct in saying that there are no non-contact ACL injury papers that use these techniques, simulated annealing is a commonly used optimization technique in the biomechanics literature, and has been for over 10 years. The tone and vagueness of the author's writing implies that these are new techniques that are at the heart of a new, integrated study approach that is better than those presently used in biomechanics research. I disagree, and wonder if this is poor writing, a difference in terminology associated with the author's background training, or is the author unaware that these techniques are commonly used in biomechanics research?	(errors) between predicted and baseline muscle simulation data. Minimizing the difference in errors using an iterative search technique is a common practice in mathematics and has nothing to do with the study methodology proposed in paper 1 and paper 2. In a later study, McLean et al. (Clin. Biomech. 23, 2008, 926-936) provided more details into the application of SA to ACL injury risk prediction. However, the application of this technique by this McLean et al. is exactly the same as mentioned above, and therefore is not as what is proposed in paper 1 or paper 2. Further, one would not be able to use this study to implement their own SA method given problem in McLean et al.'s 2008 paper is ill defined. In McLean et al. 2008 study the authors mention the objective function and variables but no constraints or constraints approach. Further, the authors used a fixed number of iterations as opposed to terminating the program against some test of optimality. Nonetheless, given McLean et al. 2008 applies SA to minimize errors between predicted and baseline muscle simulation data, it has no relevance to work presented in our paper 1 and 2. In this vain, we would like to ask that you highlight to us please the use of AI technique to the field of ACL injury biomechanics. In our paper # 1, the novelty is not in AI or OR techniques that have been exiting for many decades, but in the application and how to apply an AI technique to address the barriers to our understanding non-contact ACL injury mechanics. Paper 1 presents a way using AI to fuse existing ACL injury study approaches into a single unified environment to better understand how and why the ACL gets injured. We would ask the examiner to kindly show us a research paper that presents a paradigm that uses AI to fuse existing study approaches into a single environment with the objective to predict ACL injury. Paper 2 provides more details, awareness, and possible techniques from AI and OR communities that may be utilized in ACL injury research. Again, here the paper is focused on application of AI and OR to the study of non-contact ACL injury biomechanics, but not the entire field of biomechanics. What is exciting about paper 2 is that the research community is slowly beginning to realize that new research methodologies are required to understand ACL injury mechanics. These

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		new approaches perhaps need to borrow from each approach given each approach on its own is limited in its ability to fully capture factors implemented to increase the likelihood of ACL injuries. So, the question then is how can we capitalize on the strengths of existing study approaches so we can more comprehensively and completely capture the problem of ACL injury mechanics. One possible tool to do this is optimization, more specifically AI. The authors also present a refined way to do this in the paper 2. You are correct that AI was applied to the field of biomechanics for decades, but not to non-contact ACL injury biomechanics which is the focus of this thesis and both paper 1 and 2.
4	. ***Inconsistency between "gap" study described in papers 1 and 2 with subsequent experimental papers 3, 4, 5*** - in papers 1 and 2, the author's viewpoint on currently used study approaches is clear. A main point of both papers 1 and 2 is that ACL injuries are multi-faceted, and current approaches that try to elucidate the role of a single risk factor are inadequate. In paper 2, the author describes a better approach that would incorporate multiple risk factors within a unified research approach. Because these papers formed the literature review that was to identify "gaps" in the literature and therefore provide the rationale for the author's doctoral work, I was expecting that the subsequent experimental and modeling efforts would follow this multi-faceted	. Thanks for the feedback, and we admit that your comment is right and appreciable. But, the lack of funds, resources, skill sets, and support has forced the candidate not to pursue the development of the methodology. The development of such a methodology requires a research group with software, computing capability, and skill sets which was and still are lacking. To make Paper 1 and Paper 2 more easily publishable, the authors felt the need to add the element of a new research paradigm. This new research paradigm is something that is absent from the literature. You are correct that the existing approaches presently used in the biomechanics community were used in our research too, but this is within the limits of what can be done within the facility and resources available. Regardless, paper 1 and paper 2 are reviews of the literature that expose many gaps in knowledge in the field of ACL injury biomechanics, and a possible way to address these gaps is the new research methodology proposed. The new research methodology was added to the publication to assist getting the paper published and arguably one of the most significantly contribution.

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	approach. However, papers 3 and 4 use the typical biomechanics approach that the author had criticized in papers 1 and 2. Even in paper 5 where the author describes a MSM, it is used to further analyse the same conditions (and same experimental data?) as in paper 4, and not in the manner described in papers 1 and 2.	
5	. ***Lack of lateral and medial jump directions in papers 3, 4, 5*** – It is clear from the literature that one situation that puts the ACL at risk is movements that include a component in the medial-lateral direction in addition to anterior-posterior motion, such as "cutting" maneuvers during running. Why did the author choose to vary vertical height and anterior-posterior distance in the landing conditions, but not medial-lateral distance?	. This is a very good point. There is no consensus in the biomechanics community that side-step cutting is a non-contact ACL injury mechanism (Quatman and Hewett, Br. J Sports Med, 43, 2009; Boden, Orthopaedics, 23, 2000, Olsen, Am J Sports Med, 32, 2004). The answers to the following questions are also not given yet in biomechanics community: Does valgus collapse cause ACL injury or valgus collapse happens as a result of the ACL being injured?. At the heights and distances studied, we conducted lateral jumps but did not include these in our studies given at some of the heights and distances studied some subjects were not comfortable performing these tasks. In addition, it proved challenging to ask subjects to jump on a single-leg from all these heights and distances so many times. That's why we did not include this way of jumping in our study. Medial jumps placed the subjects at great risk of injury due to inability to regain balance with this type of jumps so it was not included in experiment. Further, medial and lateral jumps will likely lead to pronounced medial and lateral compartment forces which may lead to internal rotation of the tibia on the femur, which can dramatically increase the strain on the ACL (Markolk KL et al., 2005). In addition medial landings were seen as dangerous tasks for our study protocol given the increased risk of inducing high internal tibial rotations during this form of landing. Based on others' results, it is known that internal tibial rotations can increase ACL strain

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		(Arms SW et al. 1984, Berns GS et al. 1993) and also ACL force (Markolf KL 2005). It should also be noted that for this type of movement even though it is sagittal plane dominant, the abduction moment does play a role given the proximal femur is inherently abducted. The following papers looked at knee ab/ad for single-leg landings (Lawrence RK, Clin. Biomech. 23,6,2008; Nagano Y. et al., The Knee, 14, 2007; and Russel KA, et al., J. Athl. Training, 14,2,2006) and for double-leg landing (Decker MJ et al. Clin. Biomech. 18,7, 2003, Kernosek TW, Med.Sci. Sports Ex. 37,6, 2006, Chappel JD, Am. J. Sports. Med, 30, 2, 2002).
6	***.Incomplete description of results in papers 3, 4, 5*** - The landing experiments that form the basis for papers 3, 4 and 5 will have produced a wealth of kinematic and kinetic data that describe the time-varying changes that occur as subjects prepare and execute their landing. However, the author has chosen to describe and present very little of these data. In the first of these papers (chapter 4), there are no time series data reported at all, making it difficult for the reader to appreciate how the subjects reacted to the different landing conditions. The only data reported are peak vertical and posterior GRF, plus	. Thanks for the feedback. Yes, there is a wealth of kinematic and kinetic data but selecting as well as processing the right data to support your objectives and arguments is a demanding and challenging task. The authors provided only the data in the journals to convey the objectives of each paper. So, given this is an article style thesis one needs to be selective in what best conveys the aims and hypotheses of the paper. Also many journals have restrictions on the number of figures and tables to include (e.g. ABBE maximum is 8), so even though there is a wealth of data it does not add more knowledge than what the authors already reported. So we chose to report data that best conveyed our objectives. We have added many time history plots to the thesis as per your suggestion. . The thesis focus is on risk of ACL injury. In the literature the way to establish risk is as done in this thesis, that is, a single point is used to establish study variables (dependent variables) implicated to cause injuries, for example, initial contact, peak VGRF, peak PTASF, peak knee flexion, etc. Note, for example, the following quotes taken from scholarly literature (keep in mind please that none of these studies measured ACL strain or

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	values for some joint variables at the time of these peak GRF occurrences. One variable was knee joint work, which is calculated by integrating the knee joint power curve over some time of interest (which is not described). How are we to interpret these single value data? Do these variables also reach their peak at the time of peak VGRF or PGRF? It is inappropriate to use that single value to represent joint motion during landing execution. For example, having a knee flexion value of -33 degrees (Table 1, page 94) at the time of peak VGRF does NOT indicate the degree of knee flexion during the landing phase; it is only one measurement from a time series of knee flexion angles. The date form the basis for correlations with VGRF (Table 2), and the correlations are then interpreted with statements such as (page 96) "*Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings.*" This is incorrect, as the author has not assessed the amount of knee flexion in each landing, only the knee flexion angle that	modeled the ACL): a. "The results of this study show that the peak knee extension moment and peak proximal tibia anterior shear force are significantly correlated to each other. This result provides further support to the notion that proximal tibia anterior shear force and knee extension moment are indicators of ACL loading." (Yu B, 2006) b. "The results of this study further show that the magnitude of the peak proximal tibia anterior shear force and knee extension moments during landing of the stop-jump task are significantly correlated to corresponding peak ground reaction forces, especially the corresponding peak posterior ground reaction force. These results suggest that the peak ground reaction forces can be used to predict ACL loading conditions in future research and practice." (Yu B, 2006) c. "Hewett et al (2005) have shown that women tend to land with higher knee abduction moments (valgus torques), which are significant predictors of future ACL injury risk." (Boden B, 2009) d. "In the present study, subjects with strong hip external rotators demonstrated significantly lower VGRF during single-leg landing. This increased hip external rotator strength may provide insight as to why neuromuscular training studies have also been shown to decrease VGRF during landing (Hewett et al., 1999). The present study suggests that by improving proximal hip strength and thereby avoiding these poor landing styles the risk of ACL injuries to athletes could be lessened." (Lawrence 2008) e. "Landing with a more extended knee angle decreases the ability of the hamstring muscles to prevent anterior tibial translation, thereby increasing the risk of ACL injury. (Fagenbaum and Darling 2003)

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	occurred at peak VGRF. This "single value at time of peak GRF" is repeated in papers 4 and 5, and can lead to incorrect conclusions on any variable assessed. There are some time series data shown in papers 4 and 5, and some bar charts of gender-specific muscle forces in paper 5. In my opinion, more of these data should be reported in all 3 experimental papers.	f. We expected that women would land with more extended knees, potentially predisposing them to a greater incidence of ACL injuries. Arendt E. and Dick, R. Am. J. Sports. Med. 1995, Gomez et al. Am. J. Sports. Med.,1996). g. "Quadriceps forces can produce anterior tibial translation and increases in ACL tensile forces (Markolf KL 2004, Flemming BC, Demorat G 2004). A strong contraction of the quadriceps can cause ACL tears.(Demorat 2004)" h. Limiting the valgus position of the knee during a single-leg landing could reduce strain on the ACL and in turn reduce the number of non-contact ACL injuries. (Russel 2006) i. "The finding of increase peak VGRFs in females is important as a previous prospective study of ACL injury risk demonstrated that athletes who went on to subsequently tear their ACL had 20% greater VGRF during a drop landing." (Schmitz et al., Clin Biomech, 2007) j. "Without sufficient strength available to decelerate the body by the eccentric quadriceps mechanism, it seems that the females land in a more extended knee position and tend to maintain this extended position subsequent to ground contact rather than absorbing the impact with controlled knee flexion. This knee extended position, combined with internal hip rotation, makes females vulnerable for anterior cruciate ligament loading." (Lephart et al. Clin. Orthop. Rel. Research, 2001). k. "As compared with male college basketball players, female college basketball players did not exhibit altered knee muscle coordination characteristics that would predispose them to anterior cruciate ligament injury when landing from jumps. This conclusion is made within the parameters of this study and based on the observation that hamstring

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		muscle activation was similar for both groups. The greater knee flexion we observed in the female subjects would be expected to decrease their risk of injury." (Fagenbaum and Darling, Am. J Sport Med., 2003) Note all of these studies are done in-vitro. In none of these studies was the ACL strain or force directly measured. In most if not all of these studies the risk of ACL injury was investigated. To the authors' best knowledge, this is the norm and has been the norm for the last two decades. Now, if you randomly take any reference from this thesis in the domain of ACL injury biomechanics, you will observe the similar style inferences being made. The authors would venture to argue the same argument can be made about any other injury mechanism studied in the domain of ACL injury biomechanics. Regardless, we have added many time histories plots for many dependent variables. Also please keep in mind that many journals have limits on number of figures and tables that can be included. So, the observation of body kinematics, muscle and joint forces, and external forces as well as their interactions may help us determine how the body responds to safely reduce the impact forces. Hence, ankle, knee, hip or trunk flexion at time of peak VGRF with increased task demand may inform us as to how the body responds to these demands to attenuate impact forces and subsequently risk of ACL injury. Finally how would one use time series data of kinematics and kinetics to enable one to assess risk of injury to the ACL?
7	*Incorrect interpretation of at least some correlation data in papers 3,*	. Thanks for the feedback. Your comment of correlation between PGRF and horizontal distance is correct. We have corrected this as well as rechecked

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	4, 5 - At least some of the correlation data in these chapters have been interpreted incorrectly. For example, in paper 3, peak PGRF data are plotted as a function of horizontal distance jumped in Figure 2, page 95. Notice that on the vertical axis, the PGRF values are all negative, which is an indication that the posterior direction has been assigned to the negative, while the anterior direction is positive. Further, notice that as you scan across the graph from lower horizontal distances (30 cm)to higher ones (50 and then 70 cm), the PGRF values INCREASE in magnitude (from ~-0.6 to -0.8 for the mean). Because of the negative values assigned to the posterior direction, this forms a negative slope on the graph, and the author reports this negative correlation as "*The other significant finding of this study…*" (page 93, in Results). However, the author mis-interprets this negative slope when he states on page 97 "*Our results …… there will be a REDUCTION in peak PGRFs for landings performed at increased landing distance*". This is particularly troublesome for the GRF data, as this statement of reduced horizontal force with	all other correlations to ensure accuracy. Using a lumped mass approach and basic mechanics will confirm the accuracy of the above statements (see attachment B). Landing as seen in this thesis is 3D, includes multisegment kinematics, and most importantly includes the muscles that all work together to dampen the loads on impact. How the body dampens these impact loads is one of the mandates of this thesis. I think that just considering a lumped mass approach for single-leg landing then employing Newton's law is not a true strategy. As well, our system is not closed with respect to the momentum and energy transfer. Thus, just simply using a rough, say, conservation of linear momentum between the beginning and end of a landing trial does not seem to be correct.

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	increased jumping distance runs contrary to Newtonian physics: with increased horizontal jump distance, the horizontal take-off and landing velocities MUST increase, and the horizontal landing impulse (force X time; area under the force-time curve) MUST increase to bring the horizontal velocity to zero upon landing. One would expect the peak PGRF values to also increase in magnitude (as they do), although it is possible for the impulse to increase but not the peak PGRF. This level of mechanics knowledge should be well within the capability of a doctoral student in biomechanics. The author should carefully check the interpretation of ALL correlations, especially ones that include positive or negative signs that indicate direction (e.g. force vector components, joint angular velocities, joint moments).	
8	***.Incomplete description of subject population(s) in papers 3, 4, 5*** – In paper 3, there are 6 male subjects. In paper 4, there are 6 male subjects and 5 female subjects. Are these the same male subjects in both studies? Are the data from paper 3 and 4 from the same experimental data collection, or form 2 different data	. Are these the same male subjects in both studies? Yes Are these the same male subjects in both studies? Yes

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	collections? In paper 5, there are 3 male and 3 female subjects. Are these a subset of the subjects in papers 3 and 4? Why is EMG data only reported for the 6 subjects in paper 5? If any of the subjects / data are the same in the 3 papers, this should be noted when describing the subjects in papers 4 and 5.	Are the data from paper 3 and 4 from the same experimental data collection, or form 2 different data collections? Yes, same experimental data collection. In paper 5, there are 3 male and 3 female subjects. Are these a subset of the subjects in papers 3 and 4? The 6 subjects are a subset of the subjects in papers 4. Why is EMG data only reported for the 6 subjects in paper 5? EMG data was recorded for the purpose of MSM validation. If any of the subjects / data are the same in the 3 papers, this should be noted when describing the subjects in papers 4 and 5. . This has been done. Be aware please however, this is an article style thesis and these manuscripts are very separate papers with different objectives, hypothesis and methods.
9	***Poor statistical power in papers 3, 4, 5 due to small subject numbers*** – In the 1970s and 1980s, it was normal for biomechanics studies to have relatively few subjects due to the tedious and time consuming data analysis procedures (cinefilm methods with hand digitization, force plate data needed to be carefully synchronized, and all data	. We are intrigued by this comment. What is motivating this comment? What data have you used to make such a claim on power? From the ANOVA studies conducted the high F values indicate that we have more subjects that we really need. In fact for paper 3, we could have easily used 3 subjects and get high F statistics and powers. From work of Cohen et al. (1988) acceptable powers are assumed to be above 0.8. There are many studies in the literature where powers below 0.5 are published. However, your point may be valid for PPMC even though data reported does not substantiate your comment here as well. Recall Pearson correlation

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	reduction and analysis performed with custom written software). However, in the past 20 years we have seen the advent of automated motion capture systems which seamlessly integrate time synchronized kinematic, kinetic and EMG data, and off-the-shelf 3D analysis software (e.g. Visual 3D) and MSM software (e.g., OpenSim, AnyBody). With this improvement in data handling we have seen larger numbers of subjects in biomechanics studies, which brings greater statistical power. Why are so few subjects used in the studies described in papers 3 and 4, and particularly in paper 5? Did the author perform a statistical power test *a priori* that suggested such low subject numbers?	is not a robust analytical tool as ANOVAs. For Pearson correlations, we are trying to develop a regression equation to enable us to make predictions to any other conditions and for any subject. It is harder to get high coefficient of determinations with such small population size. Nonetheless, our data does not entirely show this. Our data does reveal significant findings for PPMCs for studies conducted. Given this, why are more subject required? Paper 5 is a musculoskeletal modeling effort and not experimental effort whose purpose was to develop, validate and apply the models to experimental data to get the internal forces. We arestill to see a MSM study applied to non-contact ACL injury mechanics that employ more than 2 subjects. We did not perform *a priori* power analysis.
10	***.Incomplete description of MSM in paper 5*** - In paper 5, the author uses subject-specific MSMs to predict the forces in internal body tissues. However, the model is not described in sufficient detail, with only general statements used such as *"The GaitFullBody MSM was … individualized for each subject"* and *"… the model is made subject-specific by employing a length mass fat scaling algorithm that uses the*	. Thanks for the feedback. The paper was changed to address all your concerns so as to better describe the model. Are differences in individual subject joint strengths (measured with a dynamometer), or muscle morphology (from MRI or ultrasound) included in the subject-specific models? .The answer is no. A simple muscle model was used that assume constant strength. Was the force plate data used as input to the

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	anthropometric data measured for each subject to scale the MSM". What data are used as inputs to the model? What anthropometric measures were used in the scaling? How many muscle models are included in the model? Are differences in individual subject joint strengths (measured with a dynamometer), or muscle morphology (from MRI or ultrasound) included in the subject-specific models? Were the muscle model force-velocity, force-length and elastic characteristics subject-specific? Was the force plate data used as input to the model, or did the model include a foot - floor interface that would generate GRFs as model outputs? How did the MSM generate its muscle model activity timing as seen in Figure 2? Was there an objective function that was optimized? Were there constraints on the solution? How were they imposed, as "hard constraints" or as penalty terms in the objective function? Which optimization algorithm was used (e.g. simulated annealing)? A much more complete description of the MSM and how it was tailored to each subject is needed.	model, or did the model include a foot - floor interface that would generate GRFs as model outputs? . Force plate and kinematic data from experiment were used as inputs to the musculoskeletal model. Was there an objective function that was optimized? Were there constraints on the solution? How were they imposed, as "hard constraints" or as penalty terms in the objective function? Which optimization algorithm was used (e.g. simulated annealing)? . There are two modelling process and models in the development of any AnyBody musculoskeletal model. First model is a kinematic model that matches the motion capture marker data from experiments with the rigid body model in AnyBody "the man". This is a kinematic optimization process whose objective function is geared towards minimizing the distance between markers from experiment and model "the man". In doing this, the man becomes scaled to the person anthropometry in experiment. The optimization process stops when there is an acceptable level of error that is set by the user. For further details of the optimization routine (by no means AI based) please see (Andersen et al. 2009). The Second model is an inverse dynamics model. This model uses a min/max objective function (Rasmussen et al. 2001). The basic optimality assumption is that "the body attempts to use its muscles in such a way that fatigue is postponed as far as possible". Hence in our optimization problem we would minimize the maximum muscle activity subject to equilibrium constraints and positive muscle force constraint (muscles can only pull).

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		AI methods are not employed in AnyBody. The software uses Newton Ralphson methods for the kinematic problem. It then uses the golden section method for inverse dynamics. How did the MSM generate its muscle model activity timing as seen in Figure 2? Details of the mathematical and mechanical methods of the AMS software are described in the literature and referenced in the paper. Please consult the following references: (Damsgaard et al. 2006; Rasmussen et al. 2001)
11	***.Use of gait data in model "validation"*** – In paper 5, the author describes the use of "*gait data collected during our study*" for purposes of validation. What gait data were collected (none was described in the experimental procedures)? Was it for the same subjects? Running? Walking? What was the progression speed? Was the gait at constant speed, or were the subjects accelerating or decelerating? Were the foot – floor interface parameters the same for gait as in single-leg landing? Should they be? And even if the gait model results were compared to literature values as in Table 1, how do we know the MSM will be valid in an impact situation with sudden deceleration such as in single-leg landing? In the absence of a comparison between model and	. Thanks for the feedback. The details of walking gait trials collected from the same subjects prior to jump landing data collection was added to the paper. Yes, the same subjects that performed the single-leg landing task performed the walking gait task. The subjects were asked to walk naturally without accelerating or decelerating while dominant leg strikes the force plate. Were the foot – floor interface parameters the same for gait as in single-leg landing? Should they be? .The foot-floor interfaces was identical for the single-leg landing task and walking gait task. We are not sure why they should be different. Any difference would need to be reflected in the MSM, as well as data used for validation which most likely does not exist in the literature. And even if the gait model results were compared to literature values as in Table 1, how do we know the MSM will be valid in an impact situation with sudden deceleration such as in single-leg landing? . This is a very good question. The answer is: we do not know. However,

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	experimental data from the single-leg landing trials, I am unconvinced that the model should be considered validated as the author states. How well do model kinematics match experimental kinematics? How well do model GRFs match subject GRFs? Did the author perform a sensitivity analysis to see which model parameters have the largest impact on the model results?	the model used from this study is a Gait full body model, which is the most heavily worked on model in the Anybody repository with over 10 years of development. This model was extensively verified and validated by other research groups for gait. Outside of this to apply this model to our application we did various things to acquire confidence in the model such as sensitivity studies, comparison of outputs with Visual 3D and muscle modeling studies. Again, given this is an article style thesis this information is not publishable. The validation process used in this study is two-fold. First, we compared EMG measured with muscle activity from model. This is the classical approach and only approach used by most MSM studies. We have added time histories of measured versus predicted muscle activity, as well as the mean correlation coefficients of muscle activation measured versus predicted for 8 muscles. To acquire greater confidence, we went a step further with our model and endeavored to compared model predictions with *in vivo* data of knee joint reaction forces and moments during single-leg landings. Unfortunately such data does not exist. However, given *in vivo* data on walking gait exist, we compared our model predictions with this. Given the efforts from above, we were given some confidence that our model is valid. In the absence of a comparison between model and experimental data from the single-leg landing trials, I am unconvinced that the model should be considered validated as the author states. How well do model kinematics match experimental kinematics? How well do model GRFs match subject GRFs? Did the author perform a sensitivity analysis to see which model parameters have the largest impact on the model results? Validation of models demands experimental data for confirmation. Such data are difficult to record and in many cases may never be obtained. As a paradox, this is actually the reason why models are developed in the first place. The validation of this work was to demonstrate that model produces

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		reasonable estimates for muscle activation patterns during single leg landing, as well as joint reaction forces during walking. To date *in-vivo* experimental data on single-leg jump landing does not exist. You were provided with two separate comparisons for validation. The comparison of muscle activity from model with experiment is quite within what would expect from these sorts of model. For the most part this is the fullest extent to knowledge provided for model validation in the literature. Further, We are convinced that our results in table 1 would be better if the subjects from *in-vivo* studies and that from experiment were closer in weight. For the *in vivo* data subjects were at least 300N heavier that the average subject weight from our study. The matching of model kinematics with experimental kinematics was within an error less than 0.5. This means the total difference between markers from experiment and markers from the model for all markers is less than 0.5 at the end of the optimization process. See sample output from objective function optimization (please see Attachment A). GRFs are used as inputs via the C3D file and unchanged in AnyBody. We performed many sensitivity studies- please see summary report (report 4), which includes studies on muscle recruitment criteria: Report 1; muscle model type (simple vs. hill): report 2; and, study to verify the large joint reaction forces and moment from developed AnyBody model: report 3.
12	• ***Omission of knee ligaments (including ACL) in MSM*** - In papers 1 and 2, the author champions the use of MSMs that will allow the estimation of internal forces acting on tissues within the body, important data that cannot be measured due to ethical considerations, and cannot be computed by standard rigid body inverse dynamics models. In paper 5	. The material properties, geometry, and constitutive law to model the four major ligaments of the knee joint is unknown or under research. The kinematics of the ACL during single-leg landing is also unknown in the scientific community. As well, ligament-bone and ligament-ligament interaction is unknown in the scientific community. The author is aware that 1D line elements can be used to model the ligaments, but this would be nothing more than a constraint (like a muscle) added to the joint to balance external forces. Thus, it seems that one dimensional assumptions are acceptable given that *in vivo* data to date on soft tissues such as the ACL are limited to force or displacement measurements.

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	the author describes the use of a MSM, but I was very surprised to find that the MSM did NOT include the ACL, which of course is the main topic of the doctoral thesis. Why was the ACL (and the other 3 major knee ligaments) omitted from the MSM? Given the title and topic of the thesis, what was the rationale for leaving the ligaments out of the model? Surely the force (stress) and strain that the ACL undergoes during the landings would be a valuable addition to the thesis?	Almost all mathematical models developed to date for the knee use one-dimensional representation for the ligaments. This is mainly because of the belief that the primary function of the ligaments is to resist tensile forces. Although one dimensional representation can be used to predict ligament forces, they are unable to predict stress distributions throughout the ligament. Including the ACL and other major ligaments of the knee joint will make it possible to deduce the net loads into loads in the anatomical structure. However, given the knee was modeled as a hinge joint, it makes no sense to model the ligaments given this will likely lead to very large ligament forces due to the incompatibility of the joint constraints and the ligament geometry. At the time this was established, it was deemed that constructing and validating an anatomical accurate knee model is a complicated and time consuming task and we think can be a PhD thesis itself. Further, even though the ligament, menisci, and articular cartilage are important in real life, these tissues can't be modeled in the software or just don't have any value for the results that can be obtained with Anybody. To model the ligaments in AnyBody, one can use the AnySeg function and aim to use a 4-bar linkage type system. This will require two bars that crisscross the knee. With each bar we introduce 6 DOF (total 12 DOF) and we require the kinematics to drive each DOF. For the connection of the bar to the bone, one can use module AnyRevoluteJoint. To use the model it must be kinematically determinate and this means that there must be enough equations to solve for all kinematic unknowns, however, given the kinematics of the ACL is unknown during movement, the bars modeled as segments cannot be used. .Also the ACL was not included given we set out to build a musculoskeletal model where the focus was to determine the muscle and joint forces patterns during various task demands and not what specifically is happening at the ACL. In all papers we used an indirect approach via risk predictor variables such as peak VGRF peak PTASF or peak PGRF as done in most work in the literature to determine risk of ACL injury.

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		.You cannot obtain stress or strains from a musculoskeletal model.
13	***.Data for males and females not reported separately in paper 5*** – In paper 5, the data and correlations in Table 3 are reported for all 6 subjects in aggregate, even though the purpose is to compare the male and female groups. The separate male and female data should also be reported, and indeed are the critical data needed to compare between male and female responses.	. Thanks for the feedback. All variables for males and females have been added in two separate tables to facilitate comparison.
14	**.Contribution of the thesis to advancing knowledge:** This is difficult to judge until the data in papers 3, 4 and 5 are described in more detail.	. Significantly more details have been added to the thesis as requested.
15	. **Research methodology:** The motion capture, force measurement and EMG data collection techniques used by the author are well established in the biomechanics community, as are the use of rigid body inverse dynamics models and musculoskeletal models. Due to lack of written detail, it is difficult to know whether the musculoskeletal models are really "subject-specific" as the author claims, and it is difficult to know how well these models represent the subject movements during the single-leg landing tasks. I do believe that the studies are under-powered due to low subject number.	. For each subject the model was individualized so that model anthropometry matches subject anthropometry through a scaling law. This law is described in the paper. The inputs to facilitate scaling are subjects' body weights, heights and in some cases their segment lengths were adjusted. The later is done when the objective function residual from the kinematic modeling process yields high errors, which brings us to your second comment. To judge how well the kinematics from subjects matched model kinematics, an optimization routine was conducted. This process involved matching all markers measured by experiment to markers from the model. An error of below 0.5 or 0.1 is acceptable (see Attachment 1). In some cases, this is hard to achieve because of quality of data recorded in experiments. . The study is not underpowered based on statistical ANOVA data reported. However, for the correlation studies we may have been able to obtain

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		higher coefficient of determination and significance in areas where no significance was observed in our study.
16	.**Analysis of results and value of conclusions:** As described in the **General Comments** section above, the data in papers 3, 4 and 5 are not described in sufficient detail. This makes it impossible to fully understand the results of the experiments, and therefore the value of the conclusions. In my opinion, there are incorrect interpretations of at least some of the correlation data presented, leaving to some incorrect conclusions.	. This has been corrected throughout after many sit downs with Statistics professor from the school of human kinetics.
17	. As described in the **General Comments** above, I have major issues with the lack of detail in the material presented in papers 3, 4 and 5. I also think that chapter 7, currently titled "Discussion", would be better described by a title such as "Summary and Future Studies". As it stands now the chapter is not really an integrated Discussion of the thesis findings, but rather a serial summary of each of the 5 papers, followed by recommendations for future research. If it is to retain its current title, the chapter needs substantial revision to include integration of the important aspects of the different papers that is not present in the separate chapters themselves.	. Chapter 7 has been retitled as suggested.
18	To accomplish this a problem is defined and formulated to determine the instance where many risk factors, many forces, and other extreme conditions happen simultaneously to cause ACL failure. In the model how do we know if this will occur in any	Thanks for the feedback. This is a very good question. The answer is: we do not know. However, we can speculate that given the MDO paradigm can handle large-scale problems and take a global look at the problem, we may better be equipped to pinpoint the key factors contributing to injury and more importantly better understand the cause of the injury.

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	human?	
19	Kinematic data were low-pass filtered using a second-order bidirectional Butterworth filter at 6 Hz and analog data were filtered at 25 Hz. Why these cutoff frequencies?	. Kinematic data filtered at 6 Hz and force plate data at 25 Hz worked out well. We did tests to ensure these frequency did not alter the raw data significantly, and retained a high percentage of the original signal content.
20	Page 99 on paper 3: Need to evaluate joint flexion, power and work over the entire time course of landing - not just one specific instant	. We are not sure how one will go about looking at knee flexion over the entire landing cycle to determine risk of ACL injury. Most studies assess kinematics, kinetics and energetics at a single point in time such as initial contact, peak VGRF, max knee flexion, etc. We specifically looked at one instant of time given it has been shown that the time of peak VGRF (which we used throughout this thesis) is the time at which peak ACL loads occur.
21	The results and discussion stemming from this study are only based on the theory of what is known about the relationship between ACL loads and GRFs. What does this mean.	.This means that peak ACL load occurs at the time of peak VGRF. This is why all kinematics, kinetics and knee energetics were selected at time of peak VGRF. This approach is to assess risk of ACL injury.
22	Paper 4: Why knee abduction moment?	. The literature has shown that knee abduction moment may also predict the risk of ACL injury (Hewett et al. 2005; Markolf et al. 1995).
23	Paper 5: How were subject specific muscle characteristics assessed.	. The MSM was made subject specific via scaling the anthropometry. The muscle characteristics were not made subject specific as this is not an easy task. Throughout this study, a simple muscle model using constant strength was used. The muscle strength of each subject was not measured during experiments. Note throughout the paper the word "subject specific" was removed and replaced with individualized.
24	Joint reaction or bone-on-bone?	.The joint reaction force will have a component of bone-on-bone contact force. The reaction forces come out of the equilibrium equations and will have all components of the externally applied loads from gravity, the load from GRF, reaction forces from other joints, and forces from muscles. .Also we have modeled anatomical joints with simplistic idealized joints,

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		for example, hinge joint for the knee, the reaction forces in this case represents what must be carried by the joint bone-on-bone contact and the soft tissue structures. In our model, we have a representation of the net loads in the joint and the direction of this load.
25	Vague how MDO does it work.	. We have added details to paper 4 to explain this further. Keep in mind thatthe AI technique used in the MDO approach proposed is a black box as shown in Figure 2 of Paper 2. The AI technique functions to fuse existing ACL injury study approaches. We have added details on page 45-46 on how this can be done using OLE or DDE.
26	The AI technique is employed to orchestrate the fusion of the two quantitative study approaches in the MDO paradigm, as well as, to facilitate search and parameter identification. Commonly done in Biomechanics.	. Not quite. Please provide a reference that shows where/how this is done in the field of biomechanics or more specifically, as per thesis topic, in the field of non-contact ACL injury biomechanics.
27	In this approach, the three qualitative study approaches are used for results validation. How? An AI technique also enables one to capture the wide variability in movement patterns to cause injury, and in tissue material properties, numerous design variables, numerous design constraints, many risk factors, and multiple objective functions. How? Vague	. Greater details have been added to pages 45-47 on how this can be done. The figures provided in paper 1 and paper 2 are also clearly telling on how to do this.
28	It is hypothesized that increasing height and distance of landing increases both the peak VGRFs and the peak PGRFs. Is this a real hypothesis. Doesn't	. Not quite. For a non-living system such as an inanimate object, we would certainly agree with you, however the human body has muscles and the kinematics (landing technique) to dampen the loads from impact, even as vertical velocity and angular moment, increases. So, even when you increase height or distance, the ground reaction forces may not necessarily increase linearly as per Newtonian mechanics because the body aims to

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	Newton's law of acceleration predicts this?	attenuate these forces. How the body does this is one of the aims of our study. Also this is a real hypothesis since we're dealing with a dynamic moving multisegment structure, in which each segment's acceleration and consequently motion is being produced by various muscles and also is being controlled quite case dependently. So, making a conclusion just based on Newton's 2nd law is practically underestimating our problem and does not seem to be a logical way to go.

There is no ISB standard for the knee joint. Further, many of the standards issued by ISB are not followed or more importantly enforced by scholarly publications, governments, university or industry.
ISEK standards for reporting EMG data is an extremely good reference, thank you.

PhD THESIS REVIEW SHEET for Examiner C	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali, Dr. Gordon Robertson, Dr. Gholamreza Rouhi	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

Examiner C

No	Examiner's C Comments and location in Original PhD thesis	Authors' Comment
1	While the sample size for the experiments is small, the results achieve statistical significance (for the population segment tested) and perhaps more importantly, partially illustrate the multifactorial analytical approach proposed by the candidate.	. What results did you use to determine N is small? The population of subjects studied were weight and height matched as much as possible. There were a total of 18 subjects tested. However, due to limitations of equipment and poor calibration of both the force plate and EMG system many of the subject data could not be used given force plate saturation and EMG system not working. Further there was a lack of human resources to help the student in the conduct of the experiments. In some cases the student was working alone to conduct many of these experiments.
2	The results are mostly properly described and analysed throughout the dissertation. Clearly, the most interesting material with regards to analysis of experimental data	The results from papers 111, 1V and V were drawn from the same sample of subjects. A study by Louw and Grimmer titled "Biomechanical factors associated with the risk of knee injury when landing from a jump" (SAJSM Vol. 18, No 1, 2006) showed that only 8% of studies justified sample size

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	is contained in Papers IV and V. However, there is some discontinuity in the results shown in both papers, although these results were assumedly obtained from the same set of experiments. This will deserve explanations during the oral defense and will likely justify revisions of the dissertation.	used. Over 50 % of the studies included less than 20 subjects and the average age of subjects in all studies was 23 years. This study also showed that males were more frequently studied than females. The authors using this as guidance and the feedback from committee members during the thesis proposal stage felt a sample size of 16 was sufficient for our objectives. Recall, initially the thesis proposal included testing only 6 subjects. No a prior power analysis was conducted. However, given force plate saturation and poor EMG data recorded some subjects data was removed from analysis.
3	. The organization and writing style of the material are acceptable, but would benefit from serious polishing and rewording/shortening of many unduly long and complex sentences. Many typos were also spotted. Many figures, graphs and tables are too small or too crowded, a problem that needs to be addressed.	. Prior to preparing to write the thesis the student sought guidance and direction from the school of human kinetics on how to prepare an article style thesis. There is no guidance or procedures available at the school of human kinetics on how to prepare an article style thesis. There is also no one at the school that can provide direction on organization style, format, font etc etc. to use for an article style thesis. To the student's best knowledge no student at the doctoral level has ever prepared an article style thesis. The figures and tables throughout the thesis were revised to make clearer. Further, many more time history plots were added based on recommendations from external examiner.
4	Para 7: Paper IV essentially repeats paper III and goes further. Therefore, one should consider the deletion of Paper III for conciseness.	Paper's 111 scope looks only at males subjects without a concern of gender effects. There is a high disparity in the ACL injury rate between genders. Why this disparity in injury rate is what paper 4 tries to understand. Paper 3 is focused only on height and distance effects on body kinematics and kinetics as well as knee energetics. Hence, the questions answered in paper III are very different from that in paper IV although the experimental method employed is identical between the two papers.

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		Given there is a dearth of information on body biomechanics and knee energetics during single leg landing from increasing heights and distance of landing, the authors felt it will be more effective to report the results from our findings in paper 111.
5		
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PhD THESIS REVIEW SHEET for Examiner D	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali, Dr. Gordon Robertson, Dr. Gholamreza Rouhi	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

Examiner D

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1	. Revise paragraph format	.Revise to what?
2	. Now much of the predictive nature of ACL injury is random and how much is predictable?	To date the answer to this question is unknown in the scientific community (see for example, Renstronm P. et al. BJSM, 2008, and Davis I.M. and Ireland M.L. 2001, Clin. Biomech.)I is beyond the scope of this thesis so we do not have a solid answer to your interesting question.
3	.The term "risk factors" is often used in a manner that leads the reader to question the appropriate use of this term. For example "To accomplish this a problem is defined and formulated to determine the instance where many risk factors, many forces, and other extreme conditions happen simultaneously to cause ACL	"In my mind this includes environmental factors (ice, etc), footwear, medication, range of motion, balance, etc. More precise terms would be useful in many situations within the thesis." If this is what is in your mind, then the use of the term "risk factors" did not mislead you as all factors you have mentioned above are indeed risk factors. As highlighted in the thesis, there is much lack of agreement and confusion on risk factors implicated to cause injury, as well as how to categorize them.

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	failure." In my mind this includes environmental factors (ice, etc), footwear, medication, range of motion, balance, etc. More precise terms would be useful in many situations within the thesis.	The risk factors may be categorized as biomechanical, environmental, anatomical and hormonal variables (Griffin et al. 2006; Renstrom et al. 2008). Many studies have concluded that these risk factors are responsible for non-contact ACL injuries, but a large number of them have focused only on one or a few risk factors, thereby failing to capture all factors at once, as well as simultaneously considering the interactions of the different risk factors involved.
4	. The first two papers try to build a rationale for an ACL research methodology, but this method was not used in the thesis. Therefore, should these papers be included in this thesis?	The first two papers are review papers that endeavored to first highlight the barriers to better understanding the mechanisms and risk factors of non-contact ACL injury. From this review, the authors aimed to identify gaps in knowledge related the field of non-contact ACL injury. This necessary first step of review of the literature is a natural part any PhD research. The authors went on to publish this work given many gaps in the literature identified can be used to steer future research direction. The authors tried to frame this review of the literature with the aim to bring some new insight and directions to this specific topic of research. Secondly these papers proposed a study methodology that may enable one to overcome the barriers to non-contact ACL injury research. To the authors' best knowledge, this information is absent from the literature. The details of this methodology is further elaborated upon, so that other researchers with larger budget, equipment, skill sets, and other resources can gain from this and perhaps employ it. The difference in the two papers' proposed study methodologies is that one is more refined than the other. This is a natural process of learning and development. Moreover, while many research groups have suggested that a multifactorial/multidisciplinary approach is required to address the challenges of non-contact ACL injury research, but none of them has proposed a study methodology yet. Thus, we think that these two

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		papers are appreciable contributions to science. The authors offer the following email from a renowned researcher in the field of non-contact ACL injury research, , , to the corresponding author on his views of Paper 1. Please note that Dr. Hashemi's work was published after Paper 1 was published.
5	.Plantiflexion should be changed to plantarflexion throughout the document	Thanks for the point- the necessary change has been made throughout the thesis.
6	.The word "gleaned" is used in the thesis. This can be changed, since the information is usually not "extracted from various sources" or "collected gradually and bit by bit"	We respect your point, but please note that various sources were indeed used, and hence word usage seems quite valid and logical.
7	.BW may be in N for paper 3 and Kg for paper 4 (Nm/BW*h). Please check and be consistent.	Please note that in both papers 3 and 4 forces were normalized to BW. So, we are consistent. In paper 4, the moments were normalized by the product of body mass and body height. We have stated BW* H, and this is incorrect as you have pointed out, so it has been corrected in all tables in paper 4. Thanks for your constructive comment.
8	.Do not replace commas with dashes. For example. "statistics -not presented- one can observe" should be "statistics, not presented, one can observe"	Thanks- change has been made throughout.
10	.Since arms motion was removed from the task, this should be considered with discussing the results	We think that this should have been suggested and discussed at the proposal stage, but not now. A point has been added to paper 111 to V to address this comment. In an effort to minimize the effect (variability due to swinging arms),

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		the arms position during the single-leg landing task was standardized. The hands remained on the iliac crest throughout the landing task to remove the variability in landing mechanics due to swinging arms. Any reduction in the variability that can be obtained will result in greater statistical power and therefore reduce the probability of committing a Type II decision error. The lack of standardization in the tasks (i.e. allowing swinging arms) may invalidate meaningful comparison. Subjects were not given any special instructions with regards to their landing mechanics to prevent experimenter bias. Further, the mass of the arms are small in comparison to the rest of the body, therefore their contribution to joint moments and forces are most likely negligible. Nonetheless, the authors accept that there may be added balance and control provided by the arms throughout the landing phase that was not included in this work, but should be discussed in the paper.
11	In paper 3, .Results must be clarified to indicate which results are linked to vertical, horizontal, or individual height analyses. .Results must be shown in tables for each height and distance condition (mean and SD)	. Change has been made to further clarify test for vertical height and test for horizontal distance. See pages 95 and 96 please. . Tables with all means and all SD have been added to page 94.
12	In paper 4, .The introduction talks mainly about the lack of literature but does not discuss the outcomes from the literature that does exist.	. Paper 4 clearly states that the study of single leg landing over increasing heights and distances that relate findings to risk of non-contact ACL injury is absent from the literature. Therefore this did not allow us to directly with our findings with this in the literature. In the

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	This section needs to be rewritten to provide the reader with an overview of the existing literature on gender differences with single leg landing. This should cover both drop landing and jump to single leg lending since both topics are relevant. You can also discuss the overall findings studies on just males and just females studies.	discussion, we highlight studies that look at a single height of two heights or compare single and double leg landings. . This comment should have been made at the thesis proposal stage, but not now. Please note that this thesis covers just single-leg landing, as was discussed and approved in the proposal defense, where you were on the thesis committee.
	.What post-hoc statistical tests were used to support statement of significance in the results (ex., Females had significantly less ankle plantiflexion angle than males)? .Post-hoc analysis is needed to explore the differences between conditions and groups	. Appreciable and important comment. At the thesis proposal stage a prior power analysis was not conducted. However, previous studies in literature such as the one provided to you at the thesis proposal defense (Louw Q and Grimmer K SAJSM 2006) that aimed to justify the sample size used for the thesis at the time (i.e. N=6) was provided. What was the outcome of this effort? Please be aware that the three papers in the thesis provides N, p and eta. Eta is a good measure of the degree to which the null hypothesis is false. Based on advice from supervisors, post-hoc studies were not conducted. However, at the thesis proposal stage similar studies on single leg landing were reviewed to query subjects used and possible power. The total number of subjects selected initially was 6, and this was later changed to 16. . This is a good question. Work was calculated as the integral over the entire power curve from start to end of the task. The decision to use the entire motion was based on the idea that the negative power curve represents energy absorption by the extensor muscles (McNitt- Gray, 1993), thus it would allow a better representation of muscular energy absorption during the entire task.

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	.What range was used for the work outcomes? .Bring all mean and SD outcomes into one table (easier for the reader to examine outcomes). Includes table 2, 4,6 .The font size is small. Tables could be revised if font size can be increased, but put these revised tables beneath each other in the manuscript. .It would be useful to have female, male, and overall mean and SD data presented, since the focus of the paper is on gender differences	. This change has been made. All values consolidated into one table (Table 3 on page 129) except those influenced by gender of which figure 7a and 7b were added. . Tables fonts are larger. Necessary changes have been made throughout. .We think that these tables are not required as statistics revealed no differences between males and females except at ankle angles. For this, just the means and SD were provided. No change required.
13	Paper 5: .See Kernozek, Torry, et al (2005)	.Paper by Kernozek et al. is for a double-leg landing from a 60 cm height only while subject is hanging from a bar. No comparison

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	.Various aspects of the validation steps on pages 128-129 are unclear. .Specifics of the subjects, data, and activity used for Anybody input should be presented. .This section combines methods and results. Separating these may help to solve the confusion for the reader.	therefore permissible with this thesis, we do believe. .What exactly is unclear? – please let us know. .Throughout these's sections has been revised to capture these changes. .Thanks for this comment. Change has been made on page 130 to 131 to make this clear.
14	.Page 24: "This work also appraises the methodological rigor"	.This change has been made on Page 24.
15	.Page 25: "revise "has been somehow patchy"	.The authors believe that it is OK and so no change is required.
16	.FaunÃ is mispelled, check foreign language character sets.	.Thanks- change made FaunØ.
17	Page 27: ."side step cutting maneuvers, to name a few" ."view of ACL injury mechanisms"	. Both changes have been made on Page 27.

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18	Page 29: "McConkey (McConkey, 1986) was the"	.This change has been made on Page 29.
19	.Page 30: "As well, muscle activity across the ankle controls the position of the foot at landing, which most likely influence the loading at the ankle" .As well, muscle activity across the ankle controls the foot position at landing, which most likely influences ankle loads.	. This change has been made on Page 30.
20	.Page 35: "Another, non contact method includes optical" .Rearrange paragraph to group contact and non-contact items	. This change has been made on Page 35.
21	.Page 37: "Computational modeling has become popular partly"	. This change has been made on Page 37.
22	.Page 37: Remove "(see for instance"	. This change has been made on Page 37.
23	.Page 39: Reword "ACL injury research is a multidisciplinary field, since one need to consult with many disciplines in a single problem"	. This change has been made on Page 39.
24	.Page 25: "Nonetheless, the prevention of sport related noncontact ACL injuries today relies largely on the ability to	.Unclear what comment is being made here- please let us know what you mean here.

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	screen at risk individuals and then modify through training the identified risk factor." .Screening for being at risk of ACL injury is not a common practice (i.e., foes not "rely largely upon) .Appropriate ACL at risk screening tools are not available	
25	.Page 26: "are among the risk factors that can be modified through training" .Listed items are not risk factors	You are correct. Sorry for the mistake. Sentence should read: "Neuromuscular control strategies and muscle strength are among the risk factors that can be modified through training (Ageberg 2007; Bryant et al. 2008; Myer et al. 2007). Change has been made on Page 25-26
26	.Page 26: What is "hand searching", reading paper copies of journals? What journals were reviewed?	At the University of Toronto, most journals can be accessed hard copies at the library. Journals in the domain of bio, or bioengineering are catalogued this way and hence were viewed this way. Specific names of these journals are among those referenced.
27	.Page 27: How did you determine that computing power was an obstacle for these studies? The choice to use slower computers does not mean that other computing options were not available.	Please read the sentence below from Page 27 which motivated this question and comment. "Fragmentation and discrepancies in the literature may be a reflection of the limitations and differences in current non-contact ACL injury study approaches which includes but not limited to, equipment used, computing power and software programs." Does this sentence say "computing power was an obstacle for these studies"?- please let us know if we need to make further clarification.

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28	.Page 27: What are the "the associated contributing risk factors"? What about the target activity and environment?	The associated risk factors can be broken down into four groups: environmental, biomechanical, neuromuscular, and hormonal (see Griffin et al. 2006). The activity is captured under kinematics and external loading, while the environment (e.g. playing surface) is a risk factor.
29	.Page 30: "that foot contact with the ground is an important risk factor in non-contact ACL injury" .Soccer players make foot contact with the ground with each step, typically without injury, therefore this risk factor statement should be reworded	.Sentence has been amended on Page 31: By one study conducted using soccer players with varying cleat designs, it was also shown that cleats that produced higher torsional resistance with the ground is associated with higher risk of non-contact ACL injury (Lambson et al. 1996).
30	.Page 31: "ground reaction forces (GRFs) cannot be transmitted effectively through the **bones to the ground**" .GRF vector is from the ground to the foot	This change has been made on Page 31: Another study found that when the foot was not flat, the ground reaction forces (GRFs) cannot be transmitted effectively through the bones from the ground without the actions of muscles (Anderson and Pandy 2003).
31	.Page 31: "the trunk and pelvis position will have coupled effects on knee angles" .The knee angle may have effect on the pelvis and trunk …	This change has been made on Page 31 and 32: Because the upper body contains over half of the total body mass, the trunk and pelvis position may likely have an effect on knee kinetics and resultant risk of ACL injury.
32	.Page 32: "The position of the leg at the time of non-contact ACL injury displays tibial rotation, apparent knee valgus, foot	The argument being made in this section of the paper is that in order to study non-contact ACL mechanics one needs to include the ankle and hip articulations (please see title on paper 31 that states: **Lack of**

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	pronation, and a relatively extended knee and hip .You did not "display" this information in the paper. What situation is being described here? More detail is needed.	**studies that include ankle and hip articulation**. This statement "The position of the leg at the time of non-contact ACL injury displays tibial rotation, apparent knee valgus, foot pronation, and a relatively extended knee and hip" is taken from findings by many researchers and written in this context to support the argument that ankle and hip inclusion in non-contact ACL injury research is indeed important. There is no specific situation being described as these kinematics can encompass varied injury mechanisms. Given this, we think that no change is required.
33	.Page 34: "These are termed contact methods and have the advantage of simultaneously including many risk factors," .How does an implanted transducer include risk factors? .All relevant muscles are typically not instrumented	You have taken the sentence out of context, and it seems that what was written was misinterpreted. The sentence read on its own will raise questions as you have here. For further clarity: .In-vivo testing using implantable transducers on human subjects, termed contact methods, has the ability to simultaneously include many risk factors given the human (which is difficult to simulate) is included in the study design while one accesses *in-vivo* data on tissues(s) of interest. By including the human in the study design one innately include muscle activation, joint forces, and applied forces. . Muscles do not need to be instrumented. . Joint contact or externally applied forces. To date we do not know how to mathematically model knee joint contact forces with accuracy. Given this, we think that no change is required.

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	Which forces?	
34	.Page 36: "The major advantage of in vitro testing is its utilization of biological tissue for testing" .In vitro can be defined as "In an artificial environment outside the living organism", so testing biological tissue need not be involved. .Testing in-vitro is a disadvantage over in-vivo, but necessary	. In vitro can be defined as "In an artificial environment outside the living organism", so testing biological tissue need not be involved. This is true as defined in the first sentence of this thesis section " . As per thesis "*In vitro* testing is conducted outside of the body typically with human subjects or post mortem human subjects (PMHS)/ cadavers. So, yes as per statement above we agree biological tissues need not be involved. . Point taken. Given this no change is required.
35	.Page 36: "In vitro testing also has the capability to simulate knee kinematics and muscle loads." .You could also use in-vivo data to drive a simulation	. I have added a sentence on Page 34 to incorporate this point for completeness- thanks for your comment.
36	.Page 36: "Other challenges with in vitro studies using cadavers are the inability to simulate realistic muscle activation and the difficulty in obtaining repeatable results" .This is the same thought as the previous sentence. .Repeatability is difficult in any biomechanical data collection with people	We have made the changes on Page 36 for further clarity: . Other challenges with *in vitro* studies using cadavers are the inability to simulate realistic and high muscle forces and the difficulty in obtaining repeatable results. .Agreed but it is even more so a challenge for in vitro studies using cadavers primarily due to the absence of muscles. Hence, without muscles cannot have repeatable kinematics (Blankvoort 1988, Naval MSc. Thesis).

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37	.Page 36: "Despite its shortcomings, in vitro studies have the capability to provide much freedom to investigate function and behavior of the ACL." .What is meant by "freedom" in this case?	. Ethical policies governing testing with humans limit the use of *in vivo* testing on humans. This limitation does not apply to *in vitro* testing. No change required.
38	.Page 36: "From this standpoint, it can be argued that gait analysis is the only way available today to determine the kinematics and kinetics during activity to cause non-contact ACL injury." .Kinematics and kinetics of what? Kinematics and kinetics of muscle-bone-ligament are typically poorly defined by gait analysis. .Can whole body kinematics and kinetics (joint angles, net joint moments, etc.) truly show the cause or just a possible body position and external loading scenario for injury? Only if you actually measure an injury?	This sentence has been revised on Page 36 to the following: From this standpoint, it can be argued that *in-vitro* studies is perhaps the only way available today or the best starting point to determine the kinematics and kinetics during activity to cause non-contact ACL injury. .This exact comment was raised and addressed by the student at the thesis proposal stage. It is not clear that what was the outcome of this effort by the student and why this question is being asked again at this stage?- please clarify.
39	.Page 37: "A computational model of the knee joint is a graphical representation of the joint anatomy" .A computational model does not have to be graphically represented to be used (i.e., a computational model is not a graphical	. Nowhere in the quote do the authors speak of "use". However there is some merit in adding the word "mathematical model" to the sentence. Change made on Page 37 to: A computational model of the knee joint is a mathematical model that can graphically represent the joint anatomy and motion.

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	representation, but can be represented graphically) ."A computational model is a mathematical model in computational science that requires extensive computational resources to study the behavior of a complex system by computer simulation"	
40	.Page 38: "The main advantage of musculoskeletal RB modeling is that it enables us to determine the forces in the muscles during activities implicated to cause non-contact ACL injuries" .Change "determine" to "estimate"	. Change has been made on Page 38.
41	.Page 39: "This may exacerbate itself to much uncertainty in theories used for teaching clinical biomechanics" .What do you mean by "This may exacerbate itself to much uncertainty"? Lack of consensus on theories? How does a lack of concensus make things worse when teaching? The instructor would present both schools of thought.	The authors appreciate this respected examiner's viewpoint and see no serious requirement for amendments. Given this no change is made.
42	.Page 40: "reductionist approach by focusing on a single factor or few factors due to small sample size." .Small sample sizes are not the reason for using methods that have	. The sentence has been reworded on Page 40 to: Finally, the low annual incident rate for ACL injury in the general population of 1 per 3000 people (Malinzak et al. 2001) -and even smaller in the athletic population- has posed

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	a small number of variables. .If over 250,000 ACL injures are reported each year in the USA, a reasonable sample size for a study can be achieved .The cost of a large study may be the real problem	challenges for researchers aiming at pinpointing factors contributing to risk of ACL injury since employing a large population of subjects in study design can be costly.
43	.Page 40-41: Various items in this proposed methodology are difficult to achieve: .That "close to injury joint kinematics" were achieved .Accurate "tibial displacement relative to femur" .Accurate "muscle tendon moment arms and lengths as well as muscle forces" for people that deviate from the model .Since the relative tissue/bone values that are modified by the AI could be wrong but create the desired output, having equivalent net joint moments, etc. does not necessarily validate the model … it just shows that equivalent net joint outcomes could be generated.	There is immense work, cost, and resources from a large research group with varied skill sets to undertake this methodology. .Like the work of this thesis, you need to focus on a motion to create a framework for which you intend to study. If single-leg landing is your scope, then experiments of this nature should first be conducted to obtain physiological motions and possible close to injury situations. The experiments conducted in the lab for this thesis are done to assess the effect of heights, distances, and gender on body kinematics and kinetics during single leg landings. This motion can then be applied to drive a model. Once this model can be validate via some order of magnitude exercise, then it can be applied in a virtual environment by perturbing it, or using an optimization tool to help you better study injury. It can be argued that the only way to study injury is via a virtual environment using physiological inputs as a starting point and an optimization tool to search and find the injury situations. . Obtaining accurate tibial displacement relative to femur was never a claim made in this thesis. No change required. . Obtaining accurate muscle tendon moment arms and lengths, as well as muscle forces were never a claim made in this thesis. The authors do believe that in the future MSM tools will enable one to customized muscle moment arms to subjects body, but from a cost benefit accuracy tradeoff point of view the authors feel this can be a useless exercise.. The methodology as proposed does not use anatomy as a design variable.

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44	.Page 43: ."Nonetheless, this approach allows for virtual experimentation which has significant implication for cost reduction through reduced equipment needs, number of subjects required for testing, and also time for testing." .Virtual experimentation would reduce costs if a "perfect" model was built that answered all questions. Since this is not the case, costs are still present to verify if modelled outcomes apply well in the real world. ."In addition, one of the central aims of this proposed approach is to provide an enabling tool to better capture the many variables,	. We do understand your concern, but in the biomechanics community validating whether a computational model outcome applies well to the real world is not a limitation of this thesis, but a limitation of science. Given the empirical tradition of the biomechanics community, one may argue that computational modeling software were perhaps slow to develop compared to that in the engineering community which undertake numerous virtual experimentation as a cost saving initiative. Further, we think a really good question is to find a study in non-contact ACL research that employs an MDO paradigm. The method is new to the field of biomechanics and if applied to the field as it is envisioned by Dr. Lloyd, Thomas Buchanan, Quatman, Marco Viceconti, Herbert Hatze etc. can yield great benefits. Herbert Hatze at the Geoffrey Dyson Memorial Lecture said that it will become obvious that a large class of problems confronting the sports biomechanists can be ultimately identified as belonging to the field of optimization. The application of MDO study paradigm is novel to the biomechanics field. MDO is a system science or system modeling approach to solving complex problems. The researchers mentioned above are among few who are critical to the conventional approaches used in the biomechanics field. How do you capture unknowns and uncertainty? . This is a very good question and really brings us to the heart of the argument as to why AI was proposed. To elaborate, how does one find the highest point in the following equation: $f(x,y)=x\sin(4x)+1.1y\sin(2y)$ $0 <= x <= 10$ $0 <= y <= 10.$ In our numerical analysis studies we leant how to solve such an

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	constraints, unknowns, uncertainty, and variability entailed in the complex problem of predicting injury mechanisms and identifying risk factors of non-contact ACL injury." .How do you capture unknowns and uncertainty? .It is unclear how the tools helps with this sentence .What do you mean by "capture the interaction" ."This approach should also aim to provide information that can connect the cause and effect relationships between ACL loading, injury mechanisms, and risk factors of noncontact ACL injury." .What information would you be providing, for example	equation, but only over a very small range of x and y. Even in this case, the problem is quite time consuming and difficult. However, a robust AI tool will allow you to have such a range. So, even though we do not know and are uncertain about the range of knee angles that causes ACL injury during single leg landing, we can say with some much certainty from what we know about the knee joint anatomy and from qualitative studies on non-contact ACL injuries the possible range of knee angles over which ACL injury occurs. Our guess for single leg landing is 10 to 45 degrees of knee flexion. These ranges are easily handled by an AI method. In addition to this, an AI tool can handle hundreds of other variables. . See comment above. .What do you mean by "capture the interaction" . The effect of increasing ankle plantar flexion on knee joint reaction forces can be determined. "This approach should also aim to provide information that can connect the cause and effect relationships between ACL loading, injury mechanisms, and risk factors of noncontact ACL injury." .What information would you be providing, for example The relationship between the GRFs, body kinematics, and ACL loads.
45	.Page 44: The first paragraphs is confusing. After rereading this many times, the author initially states that the model should	. Quite the contrary. The exact kinematics at the time of ACL injury for side-step cutting or single-leg landing is unknown. It is for this reason that one starts with close to injury situations in the laboratory using a computational model. Now assuming you have a validated

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	provide various outcome measures but then states that the kinematic information to create this model is not available so this cannot be achieved? ."One approach to resolve this challenge may be to conduct parametric and sensitivity studies" .Studies of what parameters? .An unreasonable number of studies would be required to eliminate what does not produce an injury, with the objective of only leaving conditions that cause an injury. Therefore, this is not a viable approach	computational model, how do you begin determining the mechanisms and risk factors for ACL injury?. The few attempts to do this result in many difficulties given there are likely too many parameters at play during non-contact ACL injury event. To resolve this, one can do sensitivity studies which have its pitfalls as highlighted in the thesis. . Sensitivity studies on variables one feels may or may not be a contributor to the risk of non-contact ACL injury. If there is no effect, then remove it from the problem scope. ."An unreasonable number of studies would be required to eliminate what does not produce an injury, with the objective of only leaving conditions that cause an injury. Therefore, this is not a viable approach." You may very well be right, but this is yet to proven. Sensitivity and parametric studies are a common reductionist approach to solve problems.
46	.Page 46: How can AI be used to "define a problem" .It is unclear how data from different people, different, injuries, and different conditions can be fused to generate useful information, using the proposed input data.	. This is a good question. Within the context of this thesis one can set up the objective function such as to enable the computational model to find the variables that causes the stress at the ACL to exceed yield stress within certain set variables and constraints. One will also impose physiological constraints. The objective function and constraints to capture the numerous factors involved. . Please highlight where on Page 46 such a claim is made.
47	.The author states an approach but has not provided a sufficient rationale as to how this can be implemented in practice.	. This is good point. We assume that you understand then "why the proposed approach should be implemented." Many research groups investigating non-contact ACL injury recognize that the problem is multifactorial/multidisciplinary. However, many researcher groups never proposed a way to handle such a problem. The authors of the Paper 1 and Paper 11 has endeavord to fill this gap. It is for this reason

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		that both Paper 1 and Paper 11 are appreciable contributions to science, we believe. Further, determining how to implement this approach is beyond the resources and skill sets afforded to this thesis.
48	.Page 46: "A case was not proven that "the narrow focus of some studies and the dearth of standards and specifications in the field of biomechanics appear to have the effect of limiting progress". Past study methods and standards do not limit how a research can make an advance in the ACL field. Methodological and ethical issues are more likely the limitation.	. The goal of a review paper is not to prove anything but to present what is known about the area of research and further synthesize all the unconnected topics into an integrated "state of the science" review. We will be very happy if this respected examiner can provide a specification or standard used globally by all researchers that can find direct application to non-contact ACL injury research.
49	.Page 47: Creators of ACL injury prevention programmes know how their system works. There is likely not one key element, so looking for such an element may not be warranted. The holistic approaches of avoiding vulnerable positions, increasing flexibility, increasing strength, including plyometric exercises in training, and increasing proprioception should be considered.	. What system are you referring to?- it is not clear to us. We cannot prevent or design training regimes for something we do not understand. As an example, we would be keen on seeing the body of literature that shows agreement, for example on "flexibility" "or perhaps "increasing strengthen" or any of the other variables you have mentioned, as a contributing factor to non-contact ACL injury. The question then one is compelled to ask is, why is this the case? Some of the answers are in Paper 1 and Paper 11. The proposed study paradigm can capture the factors that this respected examiner has mentioned and many others in a single problem definition.
50	.Page 58: Revise page numbers in paper reference	This change has been made on Page 58.
51	.Page 70: "compare rigid and deformable contact scenarios"	This change has been made on Page 70.

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52	.Page 71: "multivariate function that" ."The Levenberg-Marquardt algorithm can be thought of as a combination of steepest decent and Gauss-Newton methods." ."This method was modified by Fletcher (Fletcher, 1971) to tailor the amount of dampening used at each iteration so as to" ."Powell (Powell, 1978) to solve an over constrained system of equations via least squares optimization" ."The authors used an AI technique, simulated annealing, to determine" ."Monte Carlo simulations were"	This change has been made on Page 71. This change has been made on Page 71. This change has been made on Page 71. This change has been made on Page 71. This change has been made on Page 72. This change has been made on Page 72.
53	.Page 72: "Mclean et al. (Scott et al., 2004)" .Check reference and spelling of McLean. If reference from Scott's paper, put year of the McLean work.	. Spelling of McLean is correct. The references have been revised to use Scott's last name. Change made throughout the thesis- thanks for your comment.
54	.Page 75: "determine if the model can be considered valid."	. This change has been made on Page 75.
55	.Page 61: What is "combined loading" ."Non-contact ACL injury is also a whole body phenomenon that is best analyzed by simultaneously addressing multiple risk factors of	.Combined loading is forces applied simultaneously from different planes (such as would be the case in out of plane movement). . This sentence has been revised on Page 61: "Non-contact ACL injury is also a whole body

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	which neuromuscular control, joint kinematics and geometry, as well as, external forces that may be the most important." .Are the external forces the most important or other items in the sentence? How are you proving which is the most important (include reference, ...)? .Video analyses are not necessarily qualitative. They may measure frequencies of injury situations, etc.	phenomenon that is best analyzed by simultaneously addressing multiple risk factors of which neuromuscular control, externally applied forces, joint kinematics and joint geometry may be the most important." .We are not proving that any of them is more important than the other in this paper. To date no one can answer this question. . What do you mean by "frequencies of injury situations, etc." How can frequencies of injury situation enable us to gain a better understanding of injury mechanisms or risk factor?
56	.Page 69: What is meant by "Intra subject variabilities may stem from technician performing experiments"?	. Variabilities during experiment within a subject can stem from investigator managing the experiment. Hence, the way instructions are communicated to subjects, equipment setup and calibration etc. from one day to the next may be different and lead to variabilities when testing the same subject.
57	Page 70: ."A later study by Blankvoort et al. (Blankevoort and Huiskes, 1996) used the same mathematical model" .Which one, Blankevoort et al., 1991, Wismans et al., 1980? ."for usage in the model" .Which model? ."Blankvoort research group employed an optimization scheme to estimate the initial strains since no experimental data was available" .You said that the previous model was used in the last sentence?	. This has been amended for better clarity. The answer is Blackvoorte et al.'s 1991 model. Change made on Page 70. "This model was validated in a later study by Blankvoort *et al.* (Blankevoort and Huiskes 1996) whereby the effects of the initial strain of ligaments were included." . See change made on Page 70. . See the change made on Page 70 that clarifies this. . Blankvoort (1991) advanced the knee model developed by Wismans (1980) by including deformable contact at the tibiofemoral surface and the effect of ligaments wrapping around bones. The earlier model of Blankvoort (1991) showed that modeling the articular cartilage as a

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	.I do not understand "experiments via the variation of the reference strains in the ligament". Are these other experiments on people?	deformable body by adjusting the stiffness properties had little effect on model characteristics. Given this, Blankvoort later conducted a study (Blankvoort 1996) where only the initial strain of ligaments were included. Blankvoort used an optimization scheme to estimate the initial strains since no experimental data was available. Optimization was based on minimization of the difference in kinematic between the knee model and that experimentally obtained by variation of the reference strains in the line element. The ligaments were modeled as 1-D elements. Comparison of knee model's passive motion with experiment was done with data from the literature obtained from earlier studies by Blankvoort's research group (1991) using knee specimens.
58	.Page 72: .Monte Carlo methods are algorithms that randomly generate and retain the best solutions before going to the next search iteration." .This does not seem to be the case for Scott et al, 2008: "The Monte Carlo approach adopted within the current study necessarily considered each perturbed input parameter as independent from the next. In other words, for that N-dimensional space, we necessarily sampled input conditions from all corners of the hypercube. Adopting such an approach meant that some of the combined perturbed conditions would be highly unlikely in vivo, with performance of a successful sidestep being virtually impossible in these instances."	. As per the thesis that referenced McLean's 2008 paper, Monte Carlo simulations were also performed by the authors to determine the effects of variability in neuromuscular control on peak anterior drawer force, valgus moment, and internal rotation moment. In general, "Monte Carlo methods are algorithms that randomly generate and retain the best solutions before going to the next search iteration." It should be noted please that this is a weakness of Monte Carlo methods in comparison to AI approaches that can simultaneously handle numerous solutions in each iteration. . Perhaps this sentence should be reworded as "With regards to application to Biomechanics, Monte Carlo methods are used primarily to evaluate the probability of random outcomes of human movement." Please let us know if this is OK.

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	."Monte Carlo method is used primarily in this application to evaluate the probability of random outcomes of human movement." .This does not seem to be the case for Scott et al., 2008	.This sentence is not supported by the reference. This sentence is our own and no reference is required. Thus, no change has been made.
	."Monte Carlo simulation is an attractive tool since it allows researchers to study and predict risk of sustaining an injury before injury occurs." .This sentence is not supported by the reference	. "does not seem" is quite vague. What is Monte Carlo method used for and then further what is simulated annealing used for.
	."However, simulated annealing is simply mentioned by the authors but the way the method is employed to answer the author's research question is not clear .Scott provides both the equation and reference for the simulated annealing approach	. This sentence was not used in relation to McLean et al.'s (2008) work. . Yes, the way the method is employed is not clear to us even with this equation and reference. To state just the objective function is not enough. If the problem is clear to you, can you please provide us the answer to the following question: What are the constraints or constraint method use in this study?

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59	.Page 73: "whether sagittal plane knee loading during sidestep cutting could in isolation injure the ACL" .How is the injury isolated if the person is sidestep cutting and a load is applied?	. This statement is aligned with the objective of the study by Mclean et al. 2004. As per thesis the sentence reads: "McLean *et al.* (McLean et al. 2004) also applied the identical optimization methods to examine whether sagittal plane knee loading during side step cutting could in isolation injure the ACL." In the study by McLean et al. 2004, a model was used to predict the effect of perturbations in neuromuscular control (NMC) on resultant knee movement and loading. The effects of random variations in NMC during the stance phase of sidestep cutting on 3D knee loading was determined. What the author did is as follows: they investigated the effect of ONLY sagittal plane loading mechanism, comprising of quadriceps and hamstring forces, flexion angle, and external anterior-posterior joint loads (values looked at in isolation using the model) on potential to injure the ACL between genders.
60	.Page 74: "The AI technique is employed to orchestrate the fusion of the two quantitative study approaches in the MDO paradigm," .What are the MDO study approaches?	Please see Figure 2 on Page 76 where the MDO approach is presented.
61	.Page 74; It is unclear how clinical studies, interviews with athletes, video analyses will be used for validation	. As you have correctly pointed out earlier, it is possible that an AI technique can result in poor solutions. To help guide the search and optimization routine the problem must have some constraints. This is a mandatory process in ALL optimization problems. The process of

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		constraining the problem will enable us to determine physiological results. The constraints can be determined from qualitative studies such as those reported in the literature from clinical studies, video analysis, etc. As an example, from video analysis, we know that typically ACL injury occurs during single leg landing when knee is in extended position and upper body away from the knee. Given AI can handle large ranges for any given variable, we can use this intel to limit the range of knee flexion and trunk flexions for example in our problem definition.
62	.Page 74: "An AI technique also enables one to capture the wide variability in movement patterns …" .AI can also generate a wide variety of incorrect results	. Please see answer to question # 60 that can help us understand how to prevent this. The following references were added to the text to support your comments: Such a study approach may be a much more robust and comprehensive methodology to better predict non-contact ACL injuries (Lloyd et al. 2008; Quatman et al. 2009). An AI technique is preferred over OR techniques for non-contact ACL injury studies since they do not require a mathematical function, are more robust in dealing with both qualitative and quantitative variables, enables a system-based type of approach to solving complex problems (Carla 2000), and above all, they share an enhanced ability to handle many design variables and constraints over a large multimodal search space (Brown and White 1990; Holsapple et al. 1994).
63	.Page 75: "The external forces, muscle activation, and muscle forces at this specific lower extremity kinematic should …" .What do you mean by a "lower extremity kinematic"?	. Lower extremity kinematics refers to the 3D kinematics of the ankle, knee and hip.
64	.Page 77: "It was shown that present challenges in non-contact	. This paper did expose some of the challenges with existing ACL

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	ACL injury studies stem partly from the inability of existing study approaches to simultaneously capture numerous factors and parameters which are at play during ACL injury." .This was proposed, now shown (i.e., shown is usually associated with evidence, such as evidence that more factors and parameters improve clinical practice). Since error may increase with more parameters, we cannot assume that the final outcomes will be better for a particular method. .Based on this paper, the thesis should combine "biomechanical, environmental, anatomical and hormonal variables". The thesis does not include hormonal or environmental factors ."AI technique is better suited to address present challenges" .Better that OR?	injury study approaches with the aim of first determining the reasons for these challenges, but more importantly how one can go about overcoming these challenge. Given this, the use of the word shown seems appropriate. Since error may increase with more parameters, we cannot assume that the final outcomes will be better for a particular method. .This is not an issue of errors occurring due to many variables or rounding errors in various stages of analysis: What the proposed MDO approach offers is a scientific method to address the challenges in non-contact ACL injury research. What the approach brings to the forefront is the ability to tie together many disjointed disciplines or departments in single environment so that systems approach to problem solving can occur. This can be done via AI which is a scientific contribution. The five existing ACL injury study approach all have their strengths and weaknesses. Part of the authors argument is that science still does not understand how and why ACL injuries occurs given each existing study approach when used on its own can only address part of the problem and negates many aspects in the problem definition. AI can overcome this challenge. We may all agree that only a multifactorial/ mutidisciplaniary approach that fuses together these study approaches or is able to capture the variables in the 5 existing study approaches may overcome this obstacle. Now how does one go about this?. The answer lies in the use of an optimization approach. The authors have provided reasons why AI is preferred and how it can be used. . This thesis is an "article style" thesis. Each paper with its own objectives, methods, and results. The second published paper does highlight the domain of the known risk factors and how they are ALL captured in the MDO study paradigm.

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		. Yes better suited than OR. Change made on Page 78.
65	.Page 87: ."the relationship among sagittal plane body kinematics, knee power, knee work and peak GRFs." ."single-leg landings from platform heights of 20, 40, and 60 cm" ."Subjects also performed single-leg landings from a 40 cm height platform placed 30, 50 and 70 cm from the rear edge of a force plate" .Define first instance of VGRF, PGRF	. Change made Page 87. . Change made on Page 87. . Change made on Page 87. . Change made on Page 87.
66	.Page 88: "knee joint, two key factors"	. Change made on Page 88.
67	.Page 90 "that hip external rotation strength had"	. Change made on Page 90.
68	.Page 91: "Motion capture system (Vicon MX, Oxford Metrics, UK) consisting" to A seven camera motion capture system (Vicon MX, Oxford Metrics, UK) was used to collect …"	. Change made on Page 91-92.
69	.Page 92: "were instructed to stand on a variable height landing platform (20, 40, and 60 cm)" ."All kinematic data and analog data were low-pass filtered using a	. Change made on Page 92. . Change has been made on Page 92.

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	second-order bidirectional Butterworth filter at 6 Hz and 20 Hz, respectively." .This sentence could be rewritten so that the reader does not have to reread the sentence to understand, due to the use of respectively. For example, "Kinematic data were filtered using a second-order bidirectional Butterworth filter at 6Hz and analog data were filtered at 20 Hz.	
70	.Page 93: "correlations were also used to" ."finding of this study (Fig. 2) was that the horizontal" .No highlights/shading were show in Fig. 2.	. No change required as two sets of PPMC analysis were conducted. . I appreciate your suggestion. Change made on Page 93.
71	.Page 97: "Our results corroborate these findings showing that by increasing ankle plantarflexion, there"	. Change made on Page 97.
72	.Page 98: perhaps too short to allow the muscles surrounding the ankle and knee to respond."	. Change made on Page 98.
73	.Page 99: ."Further, at an increasing landing height, hip and trunk flexion may be more appropriate for attenuating GRFs" both eccentric	. Change made on Page 99. . Change made on Page 99.

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	."knee power and eccentric knee work were positively and significantly correlated to both peak VGRF"	
74	.Page 87: "more appropriate for jump landings" .You have shown that hip-trunk or ankle-knee strategies are used by the subjects, but not that these are the most appropriate.	. Our results suggest that at increasing vertical heights, hip-trunk strategy seem to be used by the subjects while for increasing distance, an ankle knee strategy is used. We have tone down this statement to your recommendations. Change made on page 88.
75	.Page 90: "Although the above-mentioned studies reported valuable findings, they lack data concerning sagittal plane kinematics and kinetics of the ankle, knee, hip, and trunk at increased height and distance of landing" .Combining the studies covers a range of heights and they do report flexion/extension biomechanics	.The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage?. Further no studies exist that look at increasing vertical height and horizontal distance. Secondly you cannot combine studies due to tremendous heterogeneity between studies as raised in the review of the literature paper we published as well as discussion from each paper's introduction. Please see Attachment A.
76	.Page 91: .Describe the identical shoes (brand, etc.) .Define the "customized marker protocol"	. The shoe used is ASICS running shoes, model BY004, ASICS America Corporation, Irvine, CA). Change made on Page 91. . The Vicon Plug-in Gait marker set was customized to include additional markers at the hip and medial aspects of the elbow, knee and ankle, as well as additional foot markers. Different marker locations were also used at the proximal ends of the pelvis and around the head. Change made on Pages 91 and 92.

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77	.Page 93: .If you are referring to the maximum VGRF, use this term instead of peak. A curve can have many peaks but only one maximum. .0.8 s before VGRF is a long time, is this correct? The entire stance phase in walking can be shorter that this time. A quick check of the literature shows 50-70 ms for time from foot strike to maximum VGRF in a jump landing and the entire event is over within 0.5 s. .Using time as the basis for work calculations can create error, as opposed to event-based criteria, since timing between individuals varies	. The first comment has merit but it is not actually valid. For a single-leg jump landing, there is only one clear distinguishable peak. See Figure 1a in Paper 4 for a good example. . Yes, 0.8s is correct for time take prior to maximum VGRF. The reason for this is first that the subject stands on both legs, transfers the weight over to the dominant leg, and then jumps. This is what takes time. "A quick check of the literature shows 50-70 ms for time from foot strike to maximum VGRF in a jump landing and the entire event is over within 0.5 s." Yes, this is perhaps true, but for what type of task?. For a vertical drop jump, maybe. So step one, peak VGRF is a clear and unambiguous event to capture. The end point being plus some time or percentage is very reasonable, because once balance has been established you would not expect large VGRF and visual inspection will verify the rationale for terminating the analysis. This leaves only the starting point, and this can be a bit vague. -0.7 second or -% from peak VGRF is a great way to standardize, because it removes issues of take off mechanics and simply states I'm only interested in what happens after this point, but prior to landing. I think this rationale stands up because the metric of interest is VGRF and the variation in the time in the air is essentially not important. "Using time as the basis for work calculations can create error, as opposed to event-based criteria, since timing between individuals

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		varies." Events were created and used for all studies.
78	Page 93: .Did you use 2D sagittal plane kinematics or 3D flexion-extension for the analysis? I is unclear why you would take 3D data and deconstruct this to 2D sagittal plane analysis, especially since the leg typically rotates out of the sagittal plane during landings. .Correlations <0.7 are not high. Do you mean relatively higher that some other analysis? Typically, 0.2 to 0.4 Weak, low correlation (not very significant); 0.4 to 0.7 Moderate correlation; 0.7 to 0.9 Strong, high correlation; 0.9 to 1.0 Very strong ."knee work as determined at the time of peak VGRF" .Work is typically over a range and not at a single value. How was this calculated? ."The means and standard deviations of the sagittal plane body kinematics, knee power, and knee	. Joint 3D kinematics were used. No deconstruction was used. Only data from a single plane used given single leg landing is sagittal plane dominant. This is a good point. The errors in camera calibration, as well as, the skin movement artifacts can be higher in magnitude that the amount of joint movement measured in some planes for the task. This is the case for transverse plane movement data such as tibial rotation, where it has been shown in the literature that skin artifacts for this measurement are larger than the measurement itself. . For clarity please note that this contradicts your comment made later in this review, where you speak to abduction moment. . Please advice how did you determine that correlation < 0.7 is not high. Please provide reference on the "typical values" suggested. The r=0.698 is taught to be high in this case given the low number of subjects used. If we are seeing this level of significance with this few subjects, then one may expect much stronger significance with more subjects. This is why the word "highly" was used.. This comment is repeated. This was a mistake in wording. Work was determined over a range, but wording needs to change to reflect this. Power is the product of joint moment and joint angular velocity. This yields a curve when integrated over time period of rotation the work done on a joint. Using events one can mark the location of peak VGRF and integrate from start of task and end at time of peak VGRF. Change has been made throughout. . Yes, it is the mean and SD for all subjects. Change made on page 92-

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	work" .Is this the mean and SD across all subjects? Please specify for text and figure captions. ."There were no significant relationships between peak VGRF and ankle or knee flexion; however, our results indicated significant correlations between both hip and trunk flexion and peak VGRF." .For which tests (vertical or horizontal)?	95. . The first statistical test was to investigate the effect of height and distance on two predictor variables, i.e. peak VGRF and peak PGRF. If there was a significant effect of height or distance on either predictors, then follow on PPMC analysis were conducted. This process is stated in the methods section. Given this, descriptive statistics of the variables significantly affected by the main effect or interaction, as well as, PPMCs between these variables and peak VGRF are provided. For greater clarity necessary change has been made on Page 93.
79	.Pages 94, 95: .In methods you indicated 6 different tests, landing from 20, 40, 60 cm and landing from 30, 50, 70 cm; however, the tables on page 94 only provide one set of means. Is this the overall mean for all trials? .Mean and SD for all subjects need to be shown for each test condition .In Figures and tables, state which test conditions are being displayed in the caption. All conditions have VGRF and PGRF values so you need to specify what the reader is seeing. .Without the data for each trial, I cannot tell from the scatter plots how each person varies between conditions. .Correlation matrix is stated but	. Yes, it is the overall means and SD for all trials. The sentence has been edited on Page 93 for the sake ofadding clarity. .These tables of all means and SD have been provided. . The change has been made to the tables. No change required on the figures given the type of test should be obvious from *x* axis label. . This is quite easy to tell from the two figures presented. There are six data points, one for each subject at each vertical height and distance (see Fig 1 and Fig 2). This paper has a set objective, thus the variation in other variables for each condition across subjects was not presented. Tables have been provided.

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	only one column of data is displayed.	. This is a good point. The word matrix is deceiving. Change has been made throughout.
80	.Page 96: ."Results of this study showed that ankle and knee flexion to be moderately and significantly correlated with peak PGRF" .0.395 is a weak correlation ."Interestingly, no significant correlation between peak PGRF and hip flexion or trunk flexion was found." .The weak correlations are more interesting than the significance, significance only states that the results is likely not by chance. In these cases, the correlations are low but this result may just be by chance. ."It was also observed that both the eccentric knee power and eccentric knee work demonstrated a moderate to high negative correlation with both the peak VGRF (r=0.493, p=0.037 and r=0.63, p=0.005, respectively) and the peak PGRF (r=0.63, p=0.005 and r=0.475, p=0.105, respectively)." .0.63 is moderate, not high .You stated negative correlations but the r values are positive	. 0.395 is a weak correlation depending on which guidelines you follow and on what you are measuring. The following guidelines was used: 0.1 to 0.3 weak 0.3 to 0.5 moderate 0.5 to 1 strong . The following guidelines was used: 0.1 to 0.3 weak 0.3 to 0.5 moderate 0.5 to 1 strong Hence the use of the term "high"

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	.It will be easier for the reader to understand this statement if they can see the results for each condition in a table	. This is a mistake. The *r* values should be negative. Change has been made throughout.
	."Results of this study (see Fig. 1 and Fig. 2) support the findings of other studies that investigated a completely different event but demonstrated a significant correlation between peak GRF and risk of knee injury"	. Repeated comment. This is a duplication of comment made earlier with regards to presenting means and standard deviation for all subjects at each trial.
	.This study does not make a link between peak GRF and knee injury risk, and figure 1 and 2 only show a trend between greater GRF for higher and longer jumping distances, as previously known.	. If it is already known that greater vertical heights and greater horizontal distances leads to higher GRFs, then please provide us the single-leg study reference(s) that show this. Further, this is only one aspect of this study. Once the effects of height, distance and gender are established, what is happening in terms of body kinematics, muscle and joint reaction forces, knee energetics as height, distance and gender change was also investigated. Further, what is the effect of these changes on risk of ACL injury?. Given the study protocol was presented to you at thesis proposal stage, we are wondering why was this not raised at that stage?.
	."Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings."	In this study, peak VGRF and peak PGRF are used as risk predictor variables. Given increasing heights leads to increase GRFs, then there is increased risk of non-contact ACL injuries at higher heights. It has been shown in other studies, as can be found in the thesis, that peak ACL loading occurs at the same time as peak VGRFs. This is the link you are looking for, we think. Further, once this link has been determined, what variables one can determine to attenuate or increase this peak VGRFs.
	.This statement is not supported. Even though the six subject's used a different strategy for dealing with landing forces, this does not mean than bending the knee cannot be used as a strategy.	. We are simply reporting our findings for the six subjects tested. We never claimed that " bending the knee cannot be used as a strategy" instead we stated that "Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore
	."This does not corroborate the study by Stacoff et al. (Stacoff et al., 1988) which showed that the	

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	knee joint angle can be used to reduce the magnitude of the impact loads during landing." .This sentence should be reworded since the results indicate that the 6 subjects did not need to increase knee flexion at maximum GRF for the test conditions, but they could have use knee flexion to reduce impact loads if required. ."However, our study is in agreement with findings of Faugenbaum et al. (Fagenbaum and Darling, 2003) who showed that factors other than knee flexion must significantly contribute to an increased risk of noncontact ACL injuries." .Since this study is not testing at an ACL injury level, the study results cannot be used to make a statement on increased risk of noncontact ACL injuries. ."Moreover, it may be inferred from our findings that the ankle may not be effective for modulating peak VGRFs at increased height of jump." .I need to see the results across heights to evaluate this statement ."Our study also showed that at increasing vertical height, an increase in hip and trunk flexion can significantly reduce peak VGRF and subsequently reducing the risk	**may have little potential** for reducing the risk of non-contact ACL injuries during single-leg landings." Incidentally this is supported in the literature. . If the subjects "could have used knee flexion to reduce impact loads if required" is presumptuous. Our data show they did not, we are simply reporting our finding. . This is a very good but untimely point, however; it is worth discussing. The vast majority of studies in the scholarly literature on non-contact ACL injury biomechanics are in the arena of *in vitro* testing. To put things into perspective, there is only one *in vivo* study to date known to the authors in this domain. Given this, the immediate question is "Since these studies are not testing – or cannot test - at an ACL injury level, **their study results cannot be used to make a statement on increased risk of non contact ACL injuries**." But we are well aware that they all do make recommendations and

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	of non-contact ACL injuries" .Your study showed that a negative correlation existed between hip and trunk flexion and jump height. Therefore, hip and trunk flexion angles were smaller at increased heights. This does not support the statement .Secondly, the study did not look at the effect of using more trunk and hip flexion at a higher height to reduce VGRF. You would have had to have subjects perform a series of jumps at the same high height but with progressively more hip or trunk flexion and the see the effect on VGRF. .Lastly, peak VGRF was not significantly reduced at the higher heights (i.e., higher height, greater VGRF)	suggestions on risk of ACL injury just like this thesis does. Now the question is why is this?. . The paper was written with a specific objective. The additional info you seek is not required, but can be inferred quite clearly from data in table 2. . ANOVA analysis was first conducted to test the effect of height on GRFs, and then the effect of distance on GRFs. After running this analysis, if there is a significant effect then we move forward. In our case, we found significance and further ventured to investigate the association between GRFs and kinematics, knee power and knee work. The statement you quoted came from the second round of analysis; given first set of analysis revealed height is associated with peak VGRF. Now table 2 shows that hip and trunk flexion are negatively and significantly correlated to peak VGRF. Since we found a negative value for the correlation between hip and trunk flexion and peak VGRF, what this implies is an inverse association (large values of *X* tend to be associated with small values of *Y* and vice versa). . No, not quite as it would defeat the objective of the thesis. We think a better question would be why we selected the variables we did in this study. Hence, why did we use sagittal plane kinematics, knee power and knee work. The answer is that we did investigate more variables but the ones presented provided the greatest level of depth for study reporting and comparisons with the literature. The second state of analysis you are questioning was meant to determine whether the body kinematics, knee power or knee work can modulate the peak GRFs. If they can, then these variables do have a

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		potential to reduce the risk of non-contact ACL injury.. It is unclear to us as to what you are asking for. The first sentence of the results section states "As reported in Fig. 1, there is a relatively high positive correlation between vertical height of landing and peak VGRF (r=0.628, p=0.005)."
81	.Page 97: ."Even though there are no single-leg landing studies to draw comparisons" .A large number of studies on single leg landing report joint angles, for many heights. These can be used for comparison. ."these findings are in agreement with the literature that reported that increased hip and trunk flexion may reduce the risk of non-contact ACL injuries" .The results do not support this statement ."Forward trunk lean and increase hip flexion may place the body COM more anterior and could potentially decrease the contraction demand for the knee extensor muscles (i.e. quadriceps muscles), while increasing the contraction demands for the hip extensors (i.e., hamstrings muscles)" .You reported a significant positive correlation for knee moments and powers, so the results do not support this statement about	. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage?. At the thesis proposal a similar claim was made. See attachment A. ALL these papers were refuted and deemed irrelevant to the scope of our work at this time. Here again you have made such claims repeatedly without justification. It would have greatly helped and be constructive if you provided these references to demonstrate this. Please provide these "large number of studies on single leg landing that report joint angles, for many heights". . Repeated comment. This comment was already made and addressed above. . Repeated comment. This was a mistake as reported earlier. The correction has been made to the tables. Text stay as it is given and it does state negative correlations between knee power and work and both peak VGRF and peak PGRF.

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	reducing demands at the knee. ."at increased distance of landing, our study found that there is a statistically significant relationship between peak PGRF and ankle and knee flexion," .The correlation between PGRF and angle flexion was not significant ."Our results corroborate these findings showing that by increasing ankle plantiflexion, there will be a reduction in peak PGRFs for landings performed at increased landing distance" .The results do not support this statement. PGRF is greater at longer distances. Since ankle dorsiflexion was defined as positive, the ankle was dorsiflexed at max PGRF. Also see previous statement about study methodology to verify this statement.	. Thanks for the point. You are right and we believe for strict accuracy this statement should be reworded. Change has been made. . The fundamental challenge in describing joint angles is the desire to have both mathematical consistency between the descriptions of the different joints (e.g. all joint angles described using the same rules), and have anatomical meaning in the resulting signals. In Visual3D joint angles are simply the transformation from one segment coordinate system to another segment coordinate system. So if two segment coordinate systems are aligned perfectly (even though they may be displaced from each other) the resulting joint angle signal is zero. The ankle angle is a good example of the inconsistency between a general method for modeling (e.g. the segment coordinate system z-axis is aligned from the distal to the proximal end of a segment) and the ankle joint angle that would result from this definition. Using this standard definition, the ankle joint angle during standing would be approximately 70 degrees of dorsi-flexion, which is not the value most people want to see. To accommodate this inconsistency Visual 3D recommends that the user create a second virtual foot segment for

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	."an increase in distance of landing led to a reduction in peak PGRF" .The results showed an increase in maximum PGRF with increasing distance (figure 2). Values are increasing negatively, due to the force plate axis convention.	which the alignment during the standing trial yields the desired joint angle. There are several ways of doing this, but two potential solutions will be described. We never did this. Instead we took the absolute value of the difference in joint angle between that when the subject was standing on the platform and that when the subject landed. Your point is valid and the necessary changes have been made on page 98. Table 2 clearly reveals that "by increasing ankle plantarflexion, there will be a reductionin peak PGRFs." See the table added to clarify this. . This is an oversight, you are correct. The correction has been made on page 98 as follows: "an increase in distance of landing led to an increase in peak PGRF." See page 98 with amendments.
82	.Page 98: ."Perhaps the answer can be found	. We could determine no reason to substantiate "why at increasing vertical heights of landing, the

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	in the time to perform such tasks. For increasing landing heights the time to perform the single-leg landing is very short, perhaps to short to allow the muscles surrounding the ankle and knee to respond." .No timing results were presented to support this statement. These results must be included in the paper. How much less time with increasing height? How does this difference relate to motor control times?	peak VGRF is poorly correlated to ankle and knee flexion and significantly correlated to both hip and trunk flexion?". Barring the results of this study, we **speculate** that "Perhaps the answer can be found in the time to perform such tasks. For increasing landing heights the time to perform the single-leg landing is very short, perhaps too short to allow the muscles surrounding the ankle and knee to respond." Please note that this is the discussion section of the paper.
	.Which time are you referring to, from airborne to landing, from ground contact to maximum force? .Without evidence, this statement should be removed.	. We are referring to from takeoff to landing. . Valid point of view– thanks for the point raised here. Our point of view is that statement remains given in the discussion we wanted to talk around and rationalize or make sense of our findings.
	."Future studies by the authors will endeavor to employ a larger sample size as well as to account for the effect of gender during single-leg landing from varying heights and distances." .This sentence is typically in the conclusions	.Appreciable point. It might be the case. But is reads and flows well with the limitations section of the discussion section.
	."The landing strategy recommended here and discussions stemming from this study"	. The paper clearly states: "Our results suggest that at increasing vertical heights, hip-trunk strategy seem to be used by the subjects, while for increasing distance, an ankle-knee strategy is used."

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	.A landing strategy was not recommended in the paper .No discussions from this study were reported ."Further in vivo and in vitro studies using a large and varied subject population, as well as computer simulation studies are needed to solidly validate our findings, and determine whether the landing strategy found actually reduces ACL loading in vivo." .This sentence can be removed since it is not related to the study (i.e., no ACL-injury inducing findings were reported in the study that would need to be validated) ."This study investigated the relationships between varying vertical height, horizontal distance, and peak GRFs during single-leg landing and further related these findings to risk of non-contact ACL injury" .The study results were not successfully related to ACL injury	. Need clarification and more expanation on this comment. .This exact comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage?. This sentence is valid. Removal of this sentence would implicate that the risk predictor variables i.e. peak VGRF and peak PGRF would have to be removed. The validity of using these two predictor variables hinges on what is known in the literature, which as you have stated here has not been proven. However, this as we have stated is a limitation of this study and most of studies of this nature. . How does one determine if a "study results are successfully related to prior studies". Given the lack of consensus and agreement in the literature as this thesis highlights, this study first reinforces earlier studies of similar nature, but more importantly it adds to the literature the aspect of how the body can modulate knee loads from increasing heights and distances, which is absent from the literature. As well, the author has related his findings to risk of non-contact ACL injury (a domain on its own) which in itself is a contribution.
83	.Page 99: ."Further, at increase height of landing, hip and trunk flexion may be more appropriate for attenuating GRFs"	. Table 2 shows a negative and significant correlation between both hip and trunk flexion and peak VGRFs. This implies a negative association. Therefore, a high hip and trunk flexion results in lower peak VGRFs. Hence, the statement seems correct to us. The claim of GRFs is misleading and the results do not show this. To be exact this

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	.This statement is not supported by the results .More appropriate that what other strategy? ."while at increase distance of landing, ankle and knee flexion may have more potential to attenuate GRFs" .This statement is not supported by the results .More potential that what other strategy? ."Hence, the biomechanical strategies for decelerating the body in the vertical and horizontal directions may be different." .You can make a stronger statement since, for your subjects, there was a clear difference between vertical and horizontal landing strategies ."In addition, both eccentric knee power and eccentric knee work was positively and significantly correlated to both peak VGRF and peak PGRF" .PGRF knee work was not significantly correlated	should state peak VGRFs as our results reveal. Change has been made on Page 99. . Note one of the claims made by other reviewers is that ankle flexion at p=0.104 is not significant. Given there were oversights in the way ankle flexion was calculated upon reanalysis, it is thought that this data is greatly significant. . More appropriate has been reworded on Page 99 to avoid any confusion. . See statement above as same argument applies. . We have reworded this statement in the discussion and have moved it up to the abstract to strengthen our argument. Change has been made on page 99 and in the abstract of this paper. . This has been reworded. Change made on page 100.
83	Text edits .Page 104: "explain the higher number of injuries among females"	. Change has been made on page 104.

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84	.Page 106: "To undertake this, a relationship between three non-contact ACL injury risk predictor variables (maximum VGRF, maximum PGRF, maximum knee abduction moment) and selected single-leg landing biomechanical variables were studied"	. Change has been made on page 107.
85	.Page 107: "The seven camera motion capture system (Vicon MX, Oxford Metrics, UK) collected marker trajectories at a sampling rate of 250 Hz."	.Change has been made on 108.
86	.Page 111: ."F(1,9)=20.91, p<0.01, partial η 2=0.699 with ankle plantarflexion angles." ."More specifically, there was a significant height×distance interaction Greenhouse-Geisser adjusted" ."interaction Greenhouse-Geisser adjusted F(3.31, 29.79) =3.73, p=0.019; partial η 2=0.293 for peak VGRF, F(2.17, 19.54) =4.13, p=0.029; partial η 2=0.315 for knee internal rotational moment, F(2.58, 112 23.22)=3.15, p=0.05, η 2=0.26 for hip flexion, and F(2.98, 26.79)=3.90, p=0.02, η 2=0.30 for trunk flexion." .This sentence is difficult to	. Repeat of previous comments. . Height mis-spelt change has been made on Page 112. . We have endeavored to do so on page 112-113.

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	read. Please revise.	
87	.Page 104: ."The number of non-contact ACL injuries is higher among females; however, there is no conclusive evidence that this is due to biomechanical differences between genders. One explanation is the lack of studies investigating gender differences in whole body biomechanics during single-leg landings from increasing vertical heights and horizontal distances." .The evidence is strong that males and females have biomechanical differences for the target activity related to landing (many studies, some with large samples). The statement should be revised ."reaction force (PGRF) for males (r=-0.85, p=0.004)," .Assuming that the 6 males are the same people as in paper 4, why is the r value different?	. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage?. Comment repeated several times. See Attachment A. This was raised and addressed by the examiner at the thesis proposal stage. What was the outcome of this exercise? The timing of this feedback is untimely, we think. Do provide these papers, "evidence", that show "that males and females have biomechanical differences for the target activity related to landing (many studies, some with large samples". Further, please let usknow what are these biomechanical differences that explain the gender disparity in ACL injury rate. Please note that as stated clearly throughout this thesis, the focus of our work is just on single-leg landing. . Please recognize that the *r* and *p* values in paper 3 were revised (See page 96) and also take note that paper 1 jump tasks studied are different from paper 4.

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88	.Page 105: ."while nearly significant and moderately correlated to peak PGRF for females (r=-0.542, p=0.13)" .0.13 is not nearly significant at the p<0.05 level	. The sentence has been revised on page 106.
	."while no significant interaction was observed for distance and gender" .Why would you anticipate an effect for distance and gender? Both gender group performed the same methods and therefore move the same distance.	. This statement was made for completeness to explain all the interactions studied.
	.What are "ankle plantiflexion angle gender effects"	. Ankle platarflexion was the only variable found to be significantly different between genders. This statement endeavors to capture this point.
	."There are few single-leg landing studies in the literature"	. Comment repeated several times. See Attachment A. A quick search on the internet is quite different than a thorough review of the content of these papers to determine its similarities or differences to this work.
	.Many single-leg landing studies are in the literature, I made a quick search and found over 16 studies so far in 2011. The review paper by Schmitz, 2007 has 34 references just on the topic of gender differences	. See Attachment A. Please review the content of these papers prior to making this claim. If you believe there is merit to your claims, then do send us these studies. Further as a member of the thesis committee why you are raising this point now?- we are just wondering why?..
		. Your statement is based on what study or finding? What you have stated is speculative. A posterior directed force must be counteracted by an extensor mechanism. If the posterior force is large, then this results in large anterior forces that pulls the tibia forward and strains the ACL. One needs to look at the force vectors to investigate this and not the resultant.
	."Further, most single-leg landing studies only report data on the knee joint kinematics and kinetics."	. This statement is based on what findings or studies- it's not clear to

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	.A sufficient number of studies report results for other joint, therefore this sentence should be revised ."Hence, peak PGRF may also predict the risk of sustaining a non-contact ACL injury" .Alternatively, it may be the increased in resultant force that is the issue and not an isolated increased in the PGRF vector. Greater VGRF also causes an increase in eccentric knee extensor moments.	us. We are likely to find a study in the biomechanics field that states the exact opposite.
89	Page 107: .Please make same changes to Procedures as outlined in the Paper 3 comments	. Requested changes have been made.
90	.Page 109: ."ACL injury risk predictor variables and various selected dependent variables" .Please list the variables ."current study did not produce the characteristics distinct biomodal GRFscurve commonly reported during double-leg landing (Dufek and Bates, 1990; Zhang et al., 2000)"	. They are too many to list. These variables are clearly labeled and listed in table 1. . This statement is important to the paper and will not be revised. It has now become more apparent why many of your previous comments were made. This is indeed a single-leg landing study and the impetus of making this very simple statement and presenting the first two figures of this paper is to clearly highlight that single-leg landing biomechanics is different from double leg landing biomechanics.

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	.The GRF curves were consistent with single leg landing curves form the literature. The sentence should be revised to compare with single leg landing and not double leg landing, since this is a single leg landing study. .This sentence should also be moved to the discussion since a literature comparison is not needed in the results. ."The demands of the current tasks studied resulted in a smoother increase to GRF" .Smoother than what? ."Therefore, the biomechanical comparisons of double leg landing with single leg landing results in the literature may be limited due to the differences exhibited by the two tasks." .Comparing single and double leg landing is not the focus of this paper, so these sentences should be removed.	.Thanks for your comment. Change has been made on page 110 and 115. . Word change to smooth on page 116. . The statement is valid as it explains why one cannot compare results from double-leg landing with single leg landing. It also explains why there is a lack of data to aid comparison with those in the literature. Finally, it helps one understands that this is the first and only study in the literature investigate the effect of increasing vertical height and horizontal distance during single-leg landing with results related to ACL injury.
91	.Page 111: ."Follow up tests with the three non-contact ACL injury risk predictor variables"	. The objective of this study was two-fold: first, to examine the effects of gender, increasing vertical height, and increasing horizontal distance on whole body kinematics and kinetics, as well as knee energetics

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	.No follow-up tests were described in the methods ."Females had significantly less ankle plantiflexion angle than males" .What stats were used for this result? ."while a moderate but near significant negative correlation for females (r=-0.542, p=0.131)" .0.131 is not near significant at the p<0.05 level	during single-leg landing; and second, to correlate the variables significantly impacted by main effects and interactions of gender, height and/or distance to three non-contact ACL injury risk predictor variables, namely peak VGRF, peak PGRF, and knee abduction moment. We have added details to clarify this. . Please see table 1 that illustrates only ankle plantarflexion was significantly different between genders and the magnitude of this difference is shown in table 2. . Wording has been changed to: "while a moderate but not significant negative correlation for females (r=-0.542, p=0.131)"
92	.Page 112: .Table 2 must provide mean and SD for all outcomes discussed in the results and discussion.	. Can we ask you to be more specific please. What exactly is being discussed in the results or discussion section for which data is not presented.. The flow of this paper follows a systematic approach. This approach is built with table 1 as the focus. First gender effects are discussed with all necessary data. Given only ankle plantarflexion was different between genders males and females data were pooled. From here interaction are studied and then main effects.

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93	.Pages 113-114: .Table 2: The results for males are strange since the ankle is more plantarflexed as the height increases but dorsiflexed (or less plantarflexed) at the longer horizontal distances. This typically means that the tibia is behind the ankle when the foot is flat (assuming maximum VGRF does not occur until the heel contacts the ground). Since the knee is approx. 28-32 degrees flexed and trunk is 17-21 deg flexed, this puts the body in a strange position (see below). The dorsiflexed ankle angle for the women seems more understandable. .As in the figure below, cofg would be behind the base of support and without arm motion recovery of balance would be difficult .Since the SD for ankle angles are	. Height has no significant impact on ankle plantarflexion angle. See table 1. This is even more reinforced by looking at the data in table 2. We have looked at the data again in visual 3D and the values obtained from males are what we have reported. . One standardizes arm location to reduce variability. Variability can be high in human motion and can prevent one from predicting anything significant. Strict experimental controls will likely introduce other limitations and traded one confounding variable for another. Further, this should have been provided to the student at the thesis proposal stage, we believe. This comment was repeated many times so far. Qualitatively only females had trouble with balance especially at the higher heights. The issue of location of body COM with respect to base of support is discussed later on in the paper. .Thanks for your comment. This is a very good point. When we looked at the scatter plots of each subject over the various landing configuration, no obvious outliers were noticed. See Attachment F that shows the scatter plot for a male and a female subject. What this figure reveals is that there is an almost linear increase of ankle flexion at each height as distance increases. Further, the Z scores of angle flexion angle for all subjects at all levels were calculated. The Z scores are provided in Attachment G. The

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	quite high (1-5x higher than the mean) does outlier data account for these differences? .This should be discussed .Table 3: Why are the correlations for males greater than in paper 3? .Are all trials across all conditions used for these correlations? .Table 5: Are these correlations for	easiest way to look for outliers with the z-scores is to scan the list for numbers greater than the absolute value of 3. For the case of ankle flexion angle, no outliers. For the case of knee, hip, trunk flexion, no outliers. . We think that you must be referring to ankle plantarflexion and PPGRF with this question. Please note that this correlation was corrected in Paper 3. Secondly as mentioned above, the tasks performed in Paper 3 and Paper 4 are different. . Yes, all trials across all conditions for each subject were used. In paper 3, not all conditions were tested. . Table 5 is for all conditions and all subjects. . For ease of readership, this was done given the systematic approached used by the paper. Given there are 4 variables that are significantly impacted by height x distance interactions, first the means and SDs are presented (see table 4) and then these four variables are correlated to the three possible ACL injury risk predictor variables (see table 5). Table 6 and table 7 follow the identical approach, but presents only the main effects of height and distance. So, given VGRF is impacted by both height x distance interactions and main effect of height, it is presented in both tables. Note that change was made throughout to correct this and to prevent duplication of data in tables.

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	all conditions and all subjects? .Data are duplicated in tables 5 and 7	
94	.Page 115: .See ankle angle comments above ."Our results revealed that females exhibited significantly lower ankle plantiflexion" .Females are dorsiflexed (Table 2) ."which offers a possible explanation to the higher number of non-contact ACL injuries among females," .Since you are analyzing the ankle angle at maximum VGRF, this point does not relate to the mentioned studies, which are considering ankle angle at initial contact ."Hence, a reduction in peak PGRF may be realized by increasing ankle plantiflexion during single-leg landing which subsequently may reduce the risk of non-contact ACL injury" .PGRF did not decrease as distance increased, so this point is not supported. ."Perhaps an increase in plantiflexion permits more time to distribute the impact forces and	. See Attachment A. See comment above. . This is correct. The word plantiflexion was removed. Change made on Page 116. . Agreed but these studies do show that ankle plantiflexion angles have the potential to modulate the GRFs. Please keep in mind that the time between initial contact and peak VGRF is short. What our finding shows is that ankle flexion is significantly different between genders and that this difference may offer a possible explanation to disparity is ACL injury rate. . The statement quoted refers to attenuating peak PGRF via ankle kinematics, distance was never mentioned. Nonetheless, changes have been made throughout page 116 to clean up the confusion with ankle plantiflexion versus dorsiflexion. . This comment was repeated. When you say "this study" we assume that you are referring to this thesis. If this is the case, what this statement is aiming to do is to substantiate our findings with that in the literature. Given this is in the discussion section, we wanted to understand why males and females use different ankle flexion during single leg landing and further support our findings with the literature as

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	better enables the musculature to absorb these forces as demonstrated by the following studies" .This study only looked at the maximum VGRF instance in time so this statement is not supported by the study. ."and implies that horizontal distance of landing--often ignored in most studies--is an important variable" .This force component is not ignored, please rephrase .Importance for what? ACL indicator? I would expect that the resultant force is the main item, with this force being larger if the person jumps farther (higher, longer, or longer and higher) ."Our results also suggest that knee abduction moment can be modulated by increasing trunk flexion" .This statement how you arrived at this statement. Please expand on this and support with the project outcomes.	done here. . We cannot understand your comment. We never mentioned anything about force components in this sentence. . Horizontal distance is important. Distance should be considered in future single-leg jump landing studies. We are not quite sure what you are saying. . You failed to include the complete sentence in this quote. "Our results also suggest that knee abduction moment can be modulated by increasing trunk flexion (see Table 5)." So table 5 is how we arrived at this statement. . The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage?. This comment is repeated several times. Many single leg landing studies do exist and these have been referenced by the authors, but there are none that studied increasing height and increasing distance then further relate these finding to risk of non-contact ACL injury. To the best of

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	."Given there are no single-leg landing studies to draw comparisons" .Many single leg landing studies exist for comparison. Please use these.	the authors' knowledge, the single leg landing studies used were those available at the time of preparing this manuscript. As mentioned before, it would have been more constructive if you please provided us these studies you felt were relevant. . We will address the ones you have mentioned. H=height D=Distance
	."Perusal of the main effects of height and distance correlated with selected biomechanical variables (see table 7) revealed that increased knee flexion angle, hip abduction angle, knee power, knee work and horizontal distance between foot and the body COM, as well as, an accompanying decrease in vertical distance between foot and the body COM, is associated with reduction in peak VGRF, thereby demonstrating the possibility of these variables to reduce the risk of non-contact ACL injury. .This statement has many problems. .VGRF increased (i.e., not reduced) .Variables increased as VGRF	. The peak VGRF increased with H and D (see table 6). Knee flexion angle decreased with increasing H (see table 6). Hip abduction angle decreases with increased H and D. Therefore, a negative correlation is reported as per analysis done using SPSS. A negative correlation implies an inverse association. What this means is an increase in X leads to decrease in Y and vice versa. Therefore, the statement with regards to knee flexion angle, that is, increase knee flexion angle is associated with reduced peak VGRFs is correct. We check all other variables you have mentioned and this statement is correct. Further, a positive correlation implies small values of X results in small values of Y, and large values of X is associated with large values of Y. So for example the vertical distance between foot center and body COM increases as H increases. As mentioned already, peak VGRF also increases with increase H. Therefore, positive correlation which implies small values of peak VGRFs is associated with small values of vertical distance between foot and body COM. . This comment was repeated several times. H=height D=distance . peak PGRF increases with increasing H and peak PGRF decreases

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	increased, so how can you prove that these variables reduced risk (i.e., variables increased but VGRF still increased) ."Without studies to draw comparisons" .Other single landing studies exists that can be used for comparison ."In addition, our results revealed that at increased in plantiflexion angle, knee flexion angle, knee power, knee work, and horizontal distance between foot and the body COM, as well as, an accompanying decrease in vertical distance between foot and the body COM is associated with a reduction in peak PGRF. .Same issues as with VGRF .PGRF either increased with greater horizontal distances or was almost unchanged (h60d30,h56d50) ."knee abduction moment and the biomechanical variables tested suggesting that knee abduction moment may be less a predictor of risk of non-contact ACL injury compared to peak VGRF and peak PGRF for single-leg landing tasks." .This may be due to the female	with increased D (see table 6). Since Knee flexion decreases with increase H, this implies a negative correlation. Checking all the other variables used revealed that this statement is correct. . This is your opinion, which we respect, but our data from this study by no means support this. We have formulated our discussion and conclusions on the findings of the paper. Q angles were not within the scope of this study. Further, weare still to see a study that shows that larger Q angles in females explains the higher rate of ACL injury among females. In addition, as per Paper 1, q angle, smaller ACL are all possible anatomical risk factors that places females at greater risk, however, these factors are not controllable, and therefore would be of no use in an injury prevention program, we think. . We do not know why females injure their ACL more than males. We both however may agree that there is a difference in average varus/valgus between males and females. Therefore, for the same applied external load, for example during landing, will require different muscle actions to maintain internal equilibrium. The authors of the following papers did just that for single-leg landings (Lawrence RK, Clin. Biomech. 23,6,2008; Nagano Y. et al., The Knee, 14, 2007; and Russel KA, et al., J. Athl. Training, 14,2,2006) and for double-leg landing (Decker MJ et al. Clin. Biomech. 18,7, 2003, Kernosek TW, Med.Sci. Sports Ex. 37,6, 2006, Chappel JD, Am. J. Sports. Med, 30, 2, 2002). Given the distal femur is inherently adducted one might argue that even with a sagittal plane dominant

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	subject sample for the study. Did the subjects have moderate-large q-angles? .If the subjects did not land in an abnormal knee abducted position, then you cannot test to see if knee abduction moment is a good indicator since the moments would be larger if the person lands with more knee abduction. .Your subjects may have been sagittal plane dominant but some people have larger frontal plane deviations (see literature on females landing)	movement like that studied in this thesis, to counter the large loads knee abduction moment may be required. Hence, some subjects may possess larger frontal plane deviations that may likely be countered with the abduction moment. Given this, the merit of reporting and studying this variable even for a sagittal plane dominant motion is interesting. Note as well please that the international Olympic committee current concepts statement (Renstrom P. et al. Br. J. Sports Med., 42,6,2008) shows that "a combination of anterior tibial translation (ATT) and lower extremity valgus are probably important components of the mechanism of injury in athletes." . We do agree that some people may have frontal plane deviations. . Firstly, this comment contradicts an early comment made on accuracy with regards to values such as tibial rotation. The body center of mass is calculated in Visual 3d, so it is the foot center. For most if not all calibration done with the vicon system, the mean residual was 1mm or under 1 mm, so one can argue that the range of 30mm is satisfactory. However, we are eager to know how you established that 3cm is within the error of identifying body COM. It is our view that the body position with respect to the BOS may give some global body (whole body) indication of risk of ACL injury given this value to date assesses balance. Given we know that an object with a lower COM is more stable, we were keen to determine how subjects used this to attenuate GRFs and stabilize their body. As well, for dynamics stability the position of body COM in relation to the BOS influences the body's stability. Given the large mechanical moment arm from body center of mass in relation to the BOS and the body's small BOS when the entire body mass has to be balanced on single leg during landing, the body's COM movement may significantly influence the loads seen at the joint especially more so when the COM is posterior to the BOS. As an example, upon landing, the literature suggests that to modulate the GRF a forward trunk lean

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	."Our findings (see table 7) reveal a significant and high positive correlation between both peak VGRF and peak PGRF, and the vertical distance between the foot and body COM supporting the findings in the literature …". .The COM results are for vertical COM distance should be discounted since this distance only changed by 3 cm (96-99 cm) and this difference is within the error of identifying COM. Therefore, the data shows that vertical COM could have no real-world effect, even through there was a correlation. .Also, you did not measure the range of COM motion so the study cannot show if COM was lowered.	may be useful (Blackburn and Padua Clin Biomech, 2008, Olsen et al AJSM 2004). . All subjects start the jump task from a standard position on two legs, move to dominant leg and then jump. Given the point of interest at which vertical distance was determine was also standardize we used this to establish globally what the entire body was doing. We wanted to see how vertically collapsed/crushed subjects were and how much this attenuated the GRFs. Interestingly, as a strong positive correlation was determined and further showed from a whole body perspective lowering the body COM can reduce the VGRFs. To date this is a value seldomly reported in the literature, but perhaps one to foster more debate in the future. . This comment was repeated several times. Due to the tremendous heterogeneity among studies in the literature, a direct comparison with our study cannot be made. No study to date investigates the effects of increasing horizontal distances on non-contact ACL injury. Further, given some variables are affected by the interaction of both height and distance, this comparison cannot be made. Please provide us studies you are referring to. . Please read the entire sentence. The authors accept that the small sample size is a limitation of this study. Given from initial tests conducted in the lab it appeared that trials were similar and given this, it was also decided that a small sample size was ok. . The sentence has been reworded to remove the phase landing strategy recommended. Change made on Page 118 . This has been amended on Page 119.

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	."Due to the lack of studies examining body kinematics and kinetics over increasing heights and distances, we are unable to fully compare our results with the literature." .If you make a table with the results from the literature, you will have information for many variables over a range of heights and distances, for many subjects. ."relatively small sample size (N=11)," .Comparison size is even smaller (n=5 for females) ."The landing strategy recommended and discussions stemming from this study" .See paper 3 ."Lower plantiflexion angles was observed for females" .Females were dorsiflexed, which will allow the ankle to progress forward to attenuate forces. The problem would be if they landed with 0 degrees and no movement occurred.	

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95	.Page 122: "While contributing to an understanding"	. Change made on page 123.
96	.Page 128: ."uses the anthropometric data measured for each subject to scale the MSM (Rasmussen, 2005). An optimization-based method …" ."taken, firstly, we compared" ."This information is presented in an on-off timing curve (Fig. 2) that shows when the measured and predicted muscles activity goes above (turns on) and below (turns off) a 20% threshold during single-leg landing. Secondly, …"	.We think that no change is required. . Change has been made on page 128. . Change has been made on page 128.
97	.Page 129: "using the subject-specific MSM, example provided in Fig. 3, after completing"	. Change has been made on page 130.
98	.Page 131: "Separate 3×3 two-within-one-between subject repeated measures ANOVAs were conducted"	. Change has been made on page 132.
99	.Page 122: ."Results revealed no significant gender differences in the musculoskeletal variables tested except peak VGRF (p=0.039), as well as, knee and hip axial compressive force (p=0.05, and p=0.032, respectively)." .In paper 4 no significant difference was found for VGRF but	. The 6 subjects used for this paper are a subset of the subjects used in paper 4, but there were height and weight match as far as possible. We re-did the stats to test the effect of gender on VGRFs and the results reported in paper 5 are correct (See attachment B). We also re-did the stats on paper 4 to make the same inquiry and the results reported for paper 4 are also correct (see Attachment C) The only small issue we can see is as follows: 1. The filter used to smooth the analog signal for visual 3D and AnyBody were a bit different. But, given all the data went through the

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	the 3 subjects that were selected for paper 5 show a significant difference. Therefore, the selection of these 6 subjects is questionable. .Since axial load is related to VGRF, these significant differences could also be attributed to subject selection from your population sample.	identical filter process, we know this should have no effect on the test for variances. Regardless, the rationalizing why this is the case fails us at this time. . Nothing special was done to select subject from the population except that they be height and weight match as closely as possible. We would really like to know how you have determined that "axial load is related to VGRF". How is it related?. Do you know the mathematical relationship that shows this relation? We are eager to know and learn from you.
100	."Our results showed no significant association between quadriceps force and risk of ACL injury" .This makes sense since you did not have injury inducing loads during testing ."Within the limitations of the subject-specific MSMs, our findings indicate that musculoskeletal variables studied are not the sole determinants to ACL injury." .It is difficult to make a statement on ACL injury based on the methodology	. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage? What are the loads to induce injury to the ACL during implicated injury mechanisms? This data DOES NOT EXIST in the scientific community. We do have *in-vitro* data and using this data. we can all agree that the experimental protocol used here exceeded the load to failure limits of the ACL. Now the question is why did the ACL did not fail? The answer perhaps lies in the body kinematics. as well as the active response of muscles to attenuate these loads during landing. . Why is it difficult?. What methodology or approach would you suggest to study risk of ACL injury during sport movements. If your statement had any validity, it would invalidate the thousands of experimental *in-vitro* and computational modeling studies in the scholarly literature in the domain of non-contact ACL injury.
101	.Page 124: .Check references for Shin	. Thank you for the references. Shin's research group work is based on a finite element model, which is quite different from a musculoskeletal

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	(2007,2009, 2011), Mokhjtarzadeh, Yeow, et al. (2010), Bulluck (2010 - Masters Thesis) for models and single leg landing	model (see paper 1 for differences). . Mokhjtarzadeh, Yeow, et al. (2010) work was published in a conference proceeding. . Work of Yeow was referenced and used for this thesis. Note that the scope and test protocol for Yeow's research group work is not the same as ours, e.g. barefoot landing, 2 heights of landing studied etc. .Could not find anything on Bullock, please provide us complete reference.. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage? This statement is untimely. See attachment A. What in our studies or that in the literature suggest that the loads at 20 cm or 60 cm are non-injury inducing. I would encourage you to review table 3a of Paper 5.
	.Since loads at 60 cm are non-injury inducing but higher than the lower heights, are the lower height trials necessary if the focus is on ACL injury?	The three heights were used to provide three data points that would enable one to study trends. Two data points will always result in a linear relationship.
	.Bulluck performed a similar study so his results should be used in the comparison. Especially since quadriceps and hamstring results were different.	. We would be glad to look into this reference to assess its merit for inclusion in this work.
	."The ability of body kinematics or lower extremity muscles to attenuate the GRFs upon landing from a single-leg requires further investigation." .This broad statement is not	. Comment repeated several times. See attachment A. Please provide these references with relevance to ACL injury that shows this knowledge is available. Injury prevention training programs aimed at reducing the incidences of non-contact ACL injury can certainly benefit if you have this knowledge.

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	supported. Many studies exist in the literature, what aspect of force attenuation is lacking? .What do you mean by "elaborate internal joint loads"?	. By elaborate we meant increase. Change has been made on page 125
102	.Page 125: .Weight and height matching of the males and female populations does not necessarily improve the methods since females are typically shorter and lighter than males. .What shoes were worn (brand, etc.)	. Weight and height matching was not done to improve the method. It was used to reduce the variability in results caused by BMI. . Change has been made on Page 126.
103	.Page 128: .Define AMS .IDA is not used later in the text so this abbreviation can be removed ."Secondly, the joint forces and moments measured in vivo at the knee joint during gait and reported in the literature were compared with predicted knee joint forces and moments" .Include reference to this gait literature. Was this walking gait? Both males and females? .This paragraph can be rewritten to more clearly show the methods. For example,	. Change has been made on Page 124 . The resubmitted manuscript uses this acronym more than once so no change required. . Change has been made on Page 129. .Yes, walking gait. .Yes, both males and females . Thank you for the suggestion offered. We feel the text reads well given the MSMs are not driven with the individual subject's knee

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	."Secondly, the joint forces and moments measured in vivo at the knee joint during gait and reported in the literature were compared with predicted knee joint forces and moments (Table 1). The MSMs were driven with the individual subject's knee joint forces and moments obtained from single leg drop landing trials.	joint forces and moments obtained from single leg drop landing trials.
	"Based on these findings and recognizing variability in body anthropometry between studies, it appears that the developed subject-specific MSMs tends to .reproduce the trends in internal forces and moments well while systematically overestimating the joint reaction forces."	
	.Which findings? The literature review?	. We are referring to the outputs from the MSMs
	.No trend for most measures in table 1 (i.e., only one comparison value)	. Change has been made on Page 130.
	.Anybody results are higher than the range for Fz and Fx only, therefore they do not reproduce the trends and did not show a systematic overestimation (Fy was not higher)	. Change has been made on Page 130
	.What are the Anybody results?	. The moments at the joints are primarily what are used to balance internal loads with externally applied loads. These moments as shown in table 1 are well within the *in vivo* data from the literature. The joint reaction force, Fy, is very nicely within the magnitude of *in vivo* data

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	Mean of all 6 subjects? ."The latter can be controlled in the MSMs by adjustment of muscle moment arms, but in the interest of reproducibility it was elected to not pursue this option." ▪What is "the latter"? ▪ So what was done to correct the models? Was the error left in place?	from the literature. . Anybody results are provide in table 1 second column labeled "predicted by AnyBody MSM". The data for the MSM is for a single subject. This subject was our heaviest subject given the body weight of subjects available in the literature. . The latter refers to the overestimation in joint reaction forces. . What correction you feel is warranted. Further, what error you speak of. A model is a representation of reality and in no means a way to directly compare with the human body. It is simply an order of magnitude comparison.
104	.Page 128: ."The time at which peak VGRF occurred was used to determine the selected musculoskeletal variables." .This sentence indicates that the VGRF time in seconds was used to select the variables used in the analysis. Since this is probably not the case, please revise.	. This sentence is correct..
105	Page 130: Figure 2: .The activity and start-end events are unclear. .Including event timing in the figure would help the reader (foot strike, etc.).	. We do not see the value in adding events at a threshold of 20%. At this threshold only initial contact may be worth reporting.
106	.Page 132: ."Nonetheless, the trends in the predicted muscle activations (thin	. By trends we mean the period of time and length of time the predicted muscle activity is over the 20% threshold.

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	lines) sets in reasonably close in time as the measured muscle activations (fat lines), therefore demonstrating fairly good agreement between model prediction and experimental data" .What do you mean be trends? .The comments of "reasonably close" and fairly good" do not support the use of the defined model for further study. Tibialis anterior and rectus femoris are quite different and the timing/duration factors could adversely affect the model's ability to predict forces. .It is not clear where Figure 3 shows the interaction with the environment	. Naturally this would be the case for any computational model given the state of science to date. Aiming for anything that is more than an order of magnitude comparison is not realistic, we believe. Just for our education how would "the time/duration factors adversely affect the model's ability to predict forces?" and How does one address this in the muscle model?. . This has been corrected on Page 133.
107	.Page 133: .Figure 3: It is questionable to state that the model has been validated due to the errors.	. Model validation is a great discourse in the field of biomechanics and is a place where anyone can easily attack. Please consult the on-off timing curves provided on for model validation. For the most part, this is the gold standard for MSM validation if validation is done in the study. We have done this and to further acquire confidence in our model we compared our model predictions to *in-vivo* data from the literature. Model validation requires experimental data to facilitate validation. In many cases, like ours, such data is difficult to obtain, or may never be obtained. The validation in this thesis is to show the model outputs reasonable trends for joint reaction and muscle activation. In general, ALL musculoskeletal models overestimates the internal forces. It

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	.A table of means and SD for main measures is required (maximum VGRF, Hip & Knee axial forces, max PGRF, max Proximal tibial shear force, etc.), with male and female results separated. .Later in the document, Table 3 provided some data, but only for the entire sample. The male and female results are needed separately since this is the analysis that is presented. ."Between genders, females had significantly lower peak VGRF, as well as, knee and hip axial compressive forces." .What statistic was used for this posthoc analysis?	seems that everyone in the musculoskeletal modeling community will agree that ALL MSMs yields larger joint forces than they would expect. We will be keen to understand what threshold of error warrants a MSM model valid in the field of biomechanics. Further, please be aware that for the *in-vivo* studies all subjects were heavier (i.e. ~335 N heavier than the heaviest subject in our study). To date, no data exist for subjects within our body weight. . This is a reasonable request for the dependent variables that are significantly different between genders. This table of values have been added on page 135. . See comment above . Mulitple 3 way mixed design with repeated measures ANOVA was used.
108	.Page 134: .Figure 4 .Revised to only show the data from foot strike onwards (inactivity from 8-85% is not needed for these graphs). .Y-axis scaling should be the same for males and females .In a printed version, I cannot	. Revisions has been made on pages 135 and 136. See Attachment D and E. . Revisions has been made on pages 135 and 136 See Attachment D and E.

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	distinguish the curves by the legend. PDF enlargement to 300% was sufficient.	. The figures are presented to show the trend in the data.
109	.Page 135: ."From descriptive statistics -not presented- one can observe an almost linear increase" .Since these statistics were not presented, I cannot observe this increase. ."Follow up test with this variable and the two non-contact ACL injury risk predictor variables revealed no significant correlation." .What was this followup-test. Please provide the methods and results or remove from the paper. .Is height the jump height or the subject's height? ."Results revealed no significant height×gender, height×distance or height×distance×gender interactions (Table 1). .Table number is incorrect in paragraph	. Take a closer look at Figure 5a please. . This comment is repeated. Follow up testing entailed Pearson product moment correlations (PPMCs) measured to determine the relationship between the two possible ACL injury risk predictor variables and the dependent variables significantly affect by an independent variable. Change made on page 132. . We assume that you are referring to Table 2. In this table, we are referring to jump height. .Change has been made.
110	.Page 137 .Figure 5: The y-axis label is muscle force; however, the EMG data was not scaled to force but to a %	. Figure 5 are outputs from the MSMs.

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	of maximum voltage. How did these data become converted to BW?	
111	.Page 138: ."This study showed that single-leg landings did not produce the characteristic bimodal VGRF curve commonly reported for double-leg landings" .Yeow (2010) had similar shaped curves in his study that tested both single and double leg landing. .The reason could be that you did not allow arm movement on landing. Therefore you are correct that the difference was related to the task but it should be mentioned that you are dealing with a "single leg landing without arm movement" and not a typical single leg landing. ."This finding is important as it elucidates the unique nature of single-leg landing studies whose findings cannot be compared with double-leg landing studies" .Revise as per previous comment ."Females may have experienced lower VGRF upon single-leg landing because of their lower quadriceps to hamstring muscle activity	. Thanks for your points. What you have highlighted simply reinforces our findings. Yeow's (2010) work was referenced throughout this thesis. . This is unfounded and speculative. Your concern about arm movement was raised already. The mass of the arms and moment of inertia of the arms are small in comparison to the rest of the body. Most important arm movement introduces variability in the data which we are trying to mitigate. . See comment above. We'd like to suggest you please take a look at a double leg landing curve in order to clarify the vague points and remove your confusion.

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	resulting in higher energy absorption and subsequently lower VGRF." .You cannot determine energy absorption since the analysis was at one point in time (VGRF). To make a conclusion, you should reanalyze the data and see if the females have greater energy absorption over the entire limb loading task.	. We are not trying to make a conclusion. We are in the discussion sections and here we are trying to rationalize our findings. Our results are non consistent with some studies in the literature and this finding does not offer us an explanation to why the incidences of ACL injury among females are higher as per hypothesis.
	."Existing single-leg landing studies in the literature … do not include the effect of the muscles" .See Shin (2007,2009, 2011), Mokhjtarzadeh, Yeow, et al. (2010), Bulluck (2010 - Masters Thesis)	
	."Our findings support this argument showing no significant association between quadriceps muscle force and the two possible non-contact ACL injury risk predictor variables."	. This comment is repeated above. See comment above.
	.It is difficult to say that the results from this study contribute to the ACK injury risk factor discussion since the subjects were not in an injury situation	. This comment is repeated several times. See comment above. You are correct- our subjects were not in an injury situation, but given the link between peak VGRF and ACL loading, as well as peak PTASF and ACL loading explained in the introduction, we can make certain claims on ACL injury like every other study in the literature.
	."Our results also corroborate other studies (Pandy and Shelburne, 1997; Yu and Garrett, 2005) that	

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	found hamstring muscles did not reduce ACL loading when knee flexion angles are small." .An analysis of hamstring muscles and knee angles was not presented in the results. ."Our results showed that increasing gastrocnemius muscle force protects the ACL by reducing both peak VGRF and peak PTASF (Table 3b)."	. Please see Table 3b that shows the correlation between hamstring muscle force and knee flexion angle. We have clarified this on page 141. "Given we did not observe a significant correlation between hamstring force and knee flexion (Table 3b) our findings do not support other studies (Pandy and Shelburne 1997; Yu and Garrett 2005) that found hamstring muscle force at large knee flexion protects the ACL."
	.Table 3b shows a negative correlation, so gastrocnemius muscle force decreased as the VGRF increased. This does not prove that the gastrocnemius protects the ACL.	. You are correct it does show a negative correlation which means an inverse association. Therefore, a high gastrocnemius muscle force results in low VGRFsn or low gastrocnemius muscle forces results in high VGRF.
	."Even though the predicted absolute values of muscle activations as well as knee joint forces and moments are overestimated, the trend agreement between …" .No trend data were provided that proves this statement	. This comment is repeated. See comments above. This is a syntax issue.
	."Given the number of variables that can affect the ACL loads in vivo, our findings suggest that musculoskeletal variables are only	. We could find no musculoskeletal variables from this study that can explain the disparity in injury rates between genders. Even for the three variables determined to be significantly different between genders, they were all significantly lower in females than males. Hence, we

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	one facet to non-contact ACL injury biomechanics, and factors such as hormones, strength training, fatigue or a combination of all these, may perhaps better explain the gender disparity in the incidences of non-contact ACL injury." .It is unclear how the study methods and results support this statement.	were not able to prove our hypothesis as true.
112	.Page 146: "To address this concern, the authors presented a novel study approach that --once developed-- can enable researchers to capture many of the parameters and extreme conditions simultaneously involved during non-contact ACL injuries" .Interestingly, the recommended method from the first two papers was not followed in this thesis. .Since the MDO method was not used in this thesis, does this show that the MDO method would be nice but may not be practically to implement.	. No, not at all. Okay a few research groups has suggested a multifactorial/MDO approach may better enable us to understand how and why the ACL gets injured. The follow on question is: have any of these groups proposed a study methodology to address this challenge. The answer is no. As such, we believe that both papers are solid contributions and beneficial for the biomechanics community. Further, within the resources, skill sets and money available to the student, this work was not undertaken.
113	.Page 149: ."Since there were no studies investigating body kinematics and kinetics during single-leg landing from increasing vertical heights	. This comment has been repeated many times. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is

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	and horizontal distance" .Studies exist for increasing heights, but not horizontal distance ."Investigations of how the body kinematics can attenuate these applied forces may provide insights into the ability of the body to reduce the loading seen at the ACL" .The studies did not look at how forces are attenuated (i.e., analysis was performed at maximum GRF) ."Furthermore, at increase height of landing, hip and trunk flexion may be more appropriate for attenuating peak VGRFs, while at increase distance of landing, ankle and knee flexion may have more potential to attenuate peak PGRFs " .Use of arms should also be considered (i.e., does lack of arm motion affect trunk position (balance, etc.)?) ."This does not corroborate the study by Stacoff and co-workers (Stacoff et al., 1988) that showed	this question being asked again at this stage?. See Attachment A. See comment above. . You have missed a fundamental link in your review of this thesis. **We CANNOT and may never be able to determine the ACL loads during an event implicated to cause injury. This is a limitation of science and not this thesis.** Hence ALL research groups to date follow the same approach of using an indirect approach to studying risk of injury like we have done here in this study. The metrics used to assess this are peak VGRFs or other risk predictor variables mentioned throughtout this thesis. These metrics were established after decades of research, and by appreciable efforts of numerous researchers. Peak VGRF and peak PGRFs are forces that once we understand how to use the body to distribute and dissipate, it will assist injury prevention and training programs. . This comment has been repeated many times. The lack of standardization in the tasks (i.e. allowing swinging arms) may invalidate meaningful comparison. See comment above.

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	that the knee joint angle could be used to reduce the magnitude of the impact loads during landings." .Less knee flexion from the study sample does not mean that the Stacoff results were incorrect, just that some other method was used. This statement should be reworded.	. This comment is repeated a couple of times. See comment above please.
114	.Please see previous comments on each paper for revisions to this section	. Change has been made throughout.
115	.Comments in this thesis review should be considered when revising the conclusions.	. Change has been made throughout.
29		
30		

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SECOND VERSION OF COMMENTS FROM STUDENT

VERSION SENT TO ALL FOUR EXAMINERS

V 2

July 2012

PhD THESIS REVIEW SHEET for Examiner A	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

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1	<u>The thesis does not constitute a significant contribution to knowledge and the analysis by the student is not of such quality as to merit publication.</u> Note: although 2 literature reviews are published, neither is in a journal particularly related to the subject matter presented. Neither describes the methodology used to decide on the chosen articles. Neither uses any criterion to evaluate the included articles. As reviews of literature, they are not significant contributions.	Many thanks for your feedback. For a graduate student to publish a review paper is a significant accomplishment and demonstrates a sound understanding of the literature. The two review papers have been published in peer-reviewed journals in disciplines closely related to the field of biomechanics. The former states that it accepts papers "in all areas of biomedical engineering" and the latter is reviewed by the Canadian Society of Mechanical Engineers and has been publishing since 1972.
	I would not consider the final three manuscripts (III, IV and V) merit publication	The problem of a small sample size has been partly remedied by adding several additional subjects to papers 3 and 4. In addition, statistical information was added to prove that the

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	due to, among other things described further on, methodological concerns such as a lack of sufficient subjects (manuscripts III, IV, V). Paper V also lacks model validation (although it is stated many times in the thesis that this has been done) and uses a male musculoskeletal model to represent females (it is simply a scaled down size of model, as pointed out to me by the co-authors on the paper). To my knowledge, this paper has also been rejected outright by the journal it was submitted to, although it is still referred to as submitted in the thesis.	sample size was acceptable. Small sample sizes can yield significant results when the statistical power is high, usually 0.80 is needed. Because of the large differences between the various conditions, a small sample size was shown statistically to be acceptable in papers 3 and 4. Paper 5 only has 6 subjects but this is not uncommon for papers that involve full musculoskeletal models. It is expected that this limitation will not preclude its publication. The MSM modeled utilized for application to single leg landing is the first of its kind in the scientific community, to the best of our knowledge, and therefore should merit publication. As it is known, the gold standard now to validate a MSM is to compare measured and predicted muscle activity as done in the thesis. However, to gain greater confidence in the model, we did many other things. One that is worth reporting in a scholarly publication is the comparison of model predictions to *in-vivo* data in the literature. To facilitate this comparison, the researcher used *in-vivo* studies where body weight and anthropometry of subjects were much higher than those used in the thesis and can likely explain why some of the joint reaction forces do not compare well. To date the data referenced in the thesis are the only data available in the scientific community, of course to the best of our knowledge. The term subject-specific was removed from the paper and term "individualized" was used as suggested. Please see revised paper. You are correct that a male MSM model was used. No female model was available. Since the MSM is individualized for each subject and because there is little difference between male and female anatomy for the lower extremity, this was not deemed a problem. Furthermore, the original accepted thesis proposal did not require developing a female model–a chore that would have taken many years of labour. In papers 3 and 4 a rigid-body model was used (see Attachment B). This model uses classical inverse dynamics analysis and inertial properties that have been individualized to the subjects tested. Furthermore, this model uses cylinders, frusta, and ovoids to represent body segment as shown in Attachment B–a common practice in biomechanics. Paper 5 was submitted and under review at the Annals of Biomedical Engineering before the thesis was submitted. Subsequently, the paper was NOT rejected outright, but was thoroughly reviewed by three reviewers at ABE and deemed unworthy for acceptance. The

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		scientific rationalization for not accepting this paper was provided by all three reviewers and has been revised and submitted to another peer-reviewed journal.
2	1. <u>The work was not done in accordance with established methodology employed by the discipline. (below is a non-exhaustive overview of some of my concerns)</u> Results of the experimental manuscripts are inconclusive and not valid due to lack of sufficient subjects in all three manuscripts. No power analysis was reported but, based on my experience in the discipline, at least 2 to 3 times the number of subjects are required in manuscripts III and IV, likely more would be required for paper V. The paper V purports to evaluate gender differences using musculoskeletal models, however (for example), only three subjects of each gender are evaluated and the model used on both genders is in fact a male model...in other words, the females are in fact treated as height and weight adjusted males. The claim in the manuscript that the model has been validated is not supported by the results. Although the use of a repeated measures ANOVA is questionable in all three experimental manuscripts due to the	This comment was partly answered above. The sample size required for a particular experiment is based on statistical power. Statistical power can be increased in many ways– one of which is increasing sample size. In this thesis the statistical power was increased in many ways and afterwards was tested to show that the sample used in papers 3 and 4 were high. When the difference between the levels of the experimental condition is high as in this thesis (30, 50, 70 cm height, 20, 40, 60 cm distance) a small sample size is acceptable to demonstrate statistical differences. The fact that significant differences were reported confirms again that the sample size was acceptable. Paper V is a modeling effort and experimental data are used to validate and drive the model. There are few MSM studies within the domain of ACL injury biomechanics with over 6 subjects. The MSM model used for this study took over 10 years of research and many PhDs and an enormous amount of money. It was not possible in the scope of this project to create a new one. However, each model was individualized to conform to the anatomy of each subject male or female. It was felt that there are few differences between the lower extremity bones of males and females. Male and female pelvises and thoraxes are very different but since the thesis was mainly concerned with the knee, this should not be a major drawback. From the ANOVA studies conducted, the high F values indicate that we have more subjects that we really need. In fact, for paper 3, we could have easily used 3 subjects and get high F statistics and powers. From work of Cohen 1988, the acceptable powers are above 0.8. There are many studies in the literature where powers below 0.5 are published. However, your point may be valid for PPMC, even though data reported does not substantiate your comment here as well. Recall Pearson correlation is not a robust analytical tool as are ANOVAs. For Pearson correlations, we are trying to develop a regression equation to enable us to make predictions to any other conditions and for any subject. It is harder to get high coefficient of determinations with such small population size and because we had to limit the number of jump heights and distances. Nonetheless, our data do not

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	number of subjects evaluated, it is particularly dubious in paper V where only three subjects are in each group, not to mention that no correction for related measures is considered, nor is the post-hoc analysis described.	entirely show this. Our data do reveal significant findings for PPMCs for the studies conducted. Paper 5 is a musculoskeletal modeling effort and not an experimental investigation. Its purpose was to develop, validate and apply the models to experimental data to get the internal forces.
	· The external validity of manuscripts III and IV is limited, as stated by the authors themselves. · The internal and external validity of paper V are limited.	
3	2. <u>The thesis does not exhibit the candidate's capacity to meet the scholarly standards required. (below is a non-exhaustive overview of some of my concerns)</u>	
	The methodological concerns noted above indicate that the candidate lacks the scholarly standards from a technical (methodological) point of view.	These concerns have been addressed above. The methods used are common and up-to-date and are regularly used by biomechanists world-wide.
	Information contained in the thesis in misleading since at least two of the declared conference presentations were never presented.	The references are included because even though the papers were not presented the papers were published as stated.

No	Examiner's A Comments and location in Original PhD thesis	Authors' Comment
	Letters from the editors of the journals with manuscripts Under Review are not provided. This is an essential first step since, to my knowledge, at least one of those manuscripts has in fact been rejected outright and this is not noted in the thesis.	Such information is not required in a thesis.
	The two accepted manuscripts are reviews of literature in journals that are not reflective of the article content and, although accepted, are of limited value due to a less than rigorous or exhaustive methodology which is not coherent with systematic reviews.	Comment is repeated. Biomechanics is a very multidisciplinary field and can only continue to progress with increased synergy between disciplines. Further, as we know,the root of the word biomechanics speaks multidisciplinary as it stems from the application of engineering mechanics to a living body.
	Manuscripts IV-V lack statistical power, adequate methodological descriptions, and inappropriate use of statistical measures.	Dealt with earlier.
	The student repeatedly states in this thesis that a lack of multifactorial research exists in the study of ACL injuries yet many of the studies sited are multifactorial in their approaches, in particular those that combine kinematics and kinetics or musculoskeletal models... the student seems to dismiss these in order to justify this thesis, instead of acknowledging what has been done and how it contributes to the field of study and	Please consult figure 2 in both paper 1 and paper 2 to better understand what the authors envision by the multifactorial approach proposed. The multifactorial approach presented is one that uses AI to combine all 5 exiting study approaches in a single unified environment. To date such an approach does not exist in the literature. Further, this type of approach is where research groups are leaning towards.

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	does not seem objective. Then, in the end, the study uses similar methodologies to form his conclusions as the papers previously criticised	
4	3. <u>Even with extensive revision, the thesis would not meet the standards required for the degree.</u> · As a body of work there are too few subjects, weak methodological and statistical approaches and overreaching conclusions beyond the evidence suggested by the results in all three experimental papers. · The two published manuscripts are of limited contribution and published in journals which are not discipline-related.	The thesis has been revised to ensure peer-reviewed publication. Other issues have been dealt with above.
5	The candidate states: *"To the best of the author's knowledge no study to date has investigated gender differences during single-leg landing from increasing vertical landing heights and horizontal landing distances."* Meanwhile, there exists a great body of knowledge about the biomechanics and associated risk factors of single leg landing under various experimental and simulated conditions, including vertical landing heights, for	Thanks for the feedback. This is the first and only study that evaluated both vertical height and horizontal distance during single-leg landing.

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	example.	
6	"*Further, there are no MSMs in the scholarly literature that has been developed, validated and applied to single-leg landing in the literature.*" Untrue, there are… not to mention that the student does not fill this purported void with the thesis.	Thanks for the feedback. It is not currently possible to fully validate MSMs since the data necessary to provide the validation would be too invasive (e.g., strain gauged tendons, ligament etc.). This study has attempted to validate the model using EMGs and comparisons with published *in vivo* studies having similar experimental conditions. This study used the best means currently available.
7	"*Further, the majority of studies in the literature pertaining to single-leg landing do not account for the effects of whole body movement on ACL loading.*" Untrue, there are… not to mention that the student does not fill this purported void with the thesis.	Thanks for the feedback. This statement has been reworded.
8	"*In addition, to the author's best knowledge, the current literature demonstrates that there are no proposed multifactorial study approaches aimed at fusing existing non-contact ACL injury study approaches into a single environment using an AI technique.*" This statement is unclear since it is unclear what the author is referring to as an AI environment. Two thing are certain: (1) many studies have used multifactorial models and approaches to investigate non-contact ACL injuries; (2) if the candidate refers to the approach he has taken in Paper-V, then it is again untrue	This is an article style thesis. Please provide a study within the domain of ACL injury biomechanics that proposes a study methodology as done in Figure 2 of paper 2. As elucidated in paper 2, there are many AI techniques. The application of a technique to fuse existing ACL injury study approaches in a single environment is novel, we think. A starting point of how to do this can be found in Figure 2 of paper 2. Please consult Attachment A from a renowned researcher in the field of ACL injury biomechanics after reviewing Paper 1 which presents the same method as in paper 2, but with improvements. Keep in mind please the date the papers published by this research group in AJSM and JOB are after Paper 1. Further the statement you quoted above has to do with the "fusion of existing non-contact ACL injury study approaches into a single-environment using an AI technique" which your two points have no bearing on.

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	and others have done this before, whereas if he is referring to some new innovative approach, the candidate has not done it in this body of work nor elucidated what that approach would be.	
9	*"These models are driven by kinematics and external forces."* The candidate is speaking of musculoskeletal models but fails to recognise the body of literature which uses EMG driven models, which are in fact driven by internal forces, as muscles are internal force generators to the system.	The author has referenced in paper 5 studies that use EMG driven musculoskeletal models applied to study ACL injury biomechanics (please see Dr. Lloyd's research group work that was referenced).
10	Very limited since the validity of the studies (both internal and external) is questionable. In particular, a lack of subjects make the results highly speculative and the statistical approaches inappropriate. There is little innovation aside from modifying jump height and distance, and the two reviews of literature are not exhaustive or systematic and seem biased.	This comment was addressed previously.
11	It must also be stated here that paper V uses commercially available software (ANYBODY) to build the model and analyse the data, not a custom model developed by the student. This is not clear in the thesis.	Please see section titled "Model development and validation" of paper 5 where your concerns were addressed. The model was taken out of the repository and individualized to each subject. This is an approach that is often used in MSM research. The model used was "individualized" for each subject by using body dimensions unique to each subject, thus each data file can be said to be customized.
12	Paper 1:	Thanks for the feedback. It was not the intention of this work to gravitate towards any

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	. The methodology described for the initial review of the literature seems initially exhaustive, however when I used one of the 4 search terms provided by the authors I turned up 3743 articles whereas the authors found 813 articles total; furthermore no criterion for triage down to the 147 articles cited is given by the authors. Considering the strong focus on modeling in the paper, at least one search term should include the word model or simulation, for example.	particular ACL injury study approach, we presented what we found. If there is a lending to any one study approach, this may be a reflection of preference of methods employed in the literature. .Finally the most significant 813 articles were reviewed for this thesis.
13	Paper 1: . One example of a lack of depth to the discussion: *"Mathematical programming and the Monte Carlo method (Blankevoort and Huiskes, 1996; McLean et al., 2003) are the current often used optimization approaches employed to study ACL mechanics. Although both mathematical programming and Monte Carlo methods have demonstrated their usefulness and effectiveness as a research tool, there are much more advanced and robust AI techniques; namely, taboo search, simulated annealing, genetic algorithms, and artificial neural networks."* In fact, "simulated annealing" is currently one of the most popular and widespread methods in musculoskeletal modeling...	The focus of paper 1 and paper 2 is in the domain of ACL injury biomechanics and overcoming existing barriers to our understanding of the mechanisms and risk factors to ACL injury and not to the entire domain of biomechanics or musculoskeletal modeling. We do accept in the paper that simulated annealing has been applied to ACL injury study by one research group. At the time of writing this paper, to the authors' best knowledge, the only application – referenced in the thesis – of an AI technique to ACL injury biomechanics was by McLean et al. (Clin Biomech. 2004 and 2008). In the earlier paper (Mclean et al. 2004) only the word simulated annealing (SA) is mentioned. How the technique is applied to this study is not provided. Regardless, the authors use SA to minimize the difference (errors) between predicted and baseline muscle simulation data. Minimizing the difference in errors using an iterative search technique is common in mathematics and has nothing to do with the study methodology proposed in paper 1 and paper 2.

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14	Paper II: It is not quite clear if this paper is a review of literature or opinion-piece on how to investigate ACL injury. To me, it is more of an opinion piece and is more suited to be in a thesis discussion then as a publication since it lacks objectivity.	The paper has been published so further discussion of its merits seem irrelevant.
15	Paper II: .It is not clear why the authors would chose this journal as it does not seem to be related to the field being investigated.	The paper has already been published.
16	Paper II: Similar concerns with regards to the approach and criterion used to select papers as paper 1 above.	The paper has already been published.
17	Paper II: This paper would serve as an introduction to the thesis, but in my opinion is not an in depth review.	The paper has already been published.
18	*Note that while I believe it is a good idea to try and publish one's thesis, papers one and two seem to be the review of literature portion of the thesis as opposed to original scientific contributions to the literature.*	Paper 1 and Paper 2 are original scientific contributions to the literature and has already been published.

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19	Manuscripts III and IV: There is a lack of subjects, putting the statistical analysis and validity in doubt. I believe that this statement by the authors is worth noting *"this study is limited by a small sample size; hence our results may not be representative of the general population and may not be conclusive. While we cannot conclude the general male population would exhibit sagittal plane body kinematics, knee power, and knee work as determine in our study for single-leg landings, we were able to show that the relationships found have a good fit in terms of r2 and p values for the six subjects tested."* The r-square and p values are questionable since there were not enough subjects to perform these tests in the first place...as a PhD thesis, this is unacceptable. These two manuscripts are better described as pilot projects or incomplete projects.	As addressed above and in the revised MS statistical was acceptable for the ANOVA. The r-values were used to demonstrate only that there was a linear increase with most of the subjects as the experimental conditions increased in difficulty.
20	Manuscripts III and IV: . Even if one considers the correlation values reported, the relatively low levels of correlation make conclusions difficult to support (a statistically significant correlation does not necessarily mean an important one...)	Be aware that adding subjects to the pool does not necessary guarantee one an increase in correlation coefficients or powers given the variability to be expected when testing humans.
21	Manuscripts III and IV:	This is true. Paper 1 and paper 2 are separate pieces of work. The lack of funds, resources, skill sets, and support has forced the candidate not to pursue the development of the

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	. The emphasis in the two reviews of literature is to avoid a reductionist approach when studying the ACL injury, yet these manuscripts do exactly that.	methodology. The development of such a methodology requires a research group with software, computing capability, and disparate skill sets, which was and still is lacking. The new research paradigm proposed is something that is absent from the scholarly literature. Regardless, paper 1 and paper 2 are reviews of the literature that exposes many gaps in knowledge in the field of ACL injury biomechanics, steers future research direction, and provides a possible way to address these gaps via the new research methodology proposed. Hence, the review of the literature does not center on this new proposed approach, but non-contact ACL injury.
22	Manuscripts III and IV: . It is unclear if the subjects from paper III were used in paper IV and this should be stated.	This has been amended to make clear in the thesis.
23	Manuscripts III and IV: . A table containing the dependant variables is not clear *"various selected dependant variables"* is the only information given.	This has been amended to provide these tables in the thesis.
24	Manuscripts III and IV: .No consideration of the inter-dependence of the selected variables is given and no correction of the probability coefficient is considered for these variables	The interdependences of various dependent variables on risk predictor is provided given the aim is to assess risk of injury. Further, the effect of an independent variable on selected dependent variables was provided. A sensitivity study may provide more information, but this approach provides a limited view of the problem as mentioned in paper 1.
25	. Given paper IV, paper III seems redundant.	. Paper 4 builds on Paper 3 by adding the effect of gender and a much larger study population. As per paper 3 "Future studies by the authors will endeavor to employ a larger sample size as well as to account for the effect of gender during single-leg landings from varying heights and distances."
26	Manuscript V:	Repeated comment. See comments above. Further, paper 5 is a modeling effort with the aim

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	·Too few subjects (3 males and 3 females) to extract meaningful conclusions. Similar to manuscripts III and IV, this manuscript is a good beginning, but not and end product.	of developing, validating and then applying MSMs to single-leg landings. This type of study and the data reported are absent from the literature and hence is deemed novel.
27	Manuscript V: . There is a lack of model validation: the authors somehow conclude that the musculoskeletal model is valid based on EMG activations which are not reflective of the predicted model-driven activations, with no objective comparisons...this makes no sense to me.	The on/off timing curve provides this objective comparison. Further to this, we have added average correlation coefficients for the 8 muscles measured with model predictions. As well, we have provided comparisons of *in vivo* joint reaction forces and moments with model predictions to aid model validation.
28	Manuscript V: The model used in this paper is not novel nor is it developed by the candidate: it is an application of a musculoskeletal model from the ANYBODY Software repertoire, which requires the user of that model to adjust the model to the input data.	As was stated in the paper 5: "The development of a MSM from the ground up is a very time consuming and complex endeavor. To mitigate these challenges, the AnyBody research group has embraced a philosophy of creating a model repository and sharing it with the public. The GaitFullBody MSM was extracted from the repository and individualized for each subject." The musculoskeletal model used for this study is the most heavily worked on and verified model in the AnyBody modeling repository hence its usage for this thesis. The development of such a model from the ground up is an enormous undertaking. Regardless, the co-authors of this paper can assure you that the modeling effort to get this model to work for application to single-leg landing was over six months of work with the software developers themselves (co-authors in this paper) in Denmark. The novelty is the application of the model to single-leg landing over increasing vertical heights and horizontal distances which has never been reported in the literature. Further, a MSM investigating single-leg landings does not exist in the literature hence the novelty. To achieve stability for MSMs applied to high acceleration tasks such as for single-leg landings is no trivial task and has never before been conducted.
29	Manuscript V: The model used for the female subjects is a scaled version of the male model, not a gender-specific model. As such, it cannot	Addressed previously. Please note, the purpose of the paper is not to investigate anatomical differences.

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	take into account physiological and anatomical differences between the sexes, even though the purpose of the paper is to evaluate these things.	
30	.The statistical analysis of the results is questionable due to the small sample sizes in all manuscripts.	See comments above.
31	. The validity of the model used in paper V is not established; the use of a male musculoskeletal model to represent females is questionable, in particular given the anatomical and neuromuscular sex-related differences highlighted by the candidate, for example.	.One may argue that there is no difference is lower extremity anatomy below the pelvis between genders. This problem was not addressed nor required by the committee that reviewed the thesis proposal so is beyond the scope of the current thesis.
32	.The value of the conclusions was accurately put into doubt by the candidates own statements regarding a lack of sample size for manuscripts III and IV.	Addressed above.
33	.The value of the conclusions for paper V are in doubt due to a lack of sample size and the above mentioned lack of model validation and use of a male model to represent females.	Addressed above.

PhD THESIS REVIEW SHEET for Examiner B	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

Examiner B

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1	. ***Lack of anatomical description of the knee structures and the role of the ACL within this overall structure*** – Given the thesis topic, early in the thesis it would be appropriate to include a detailed description of the knee anatomy and function, including clear diagrams of the ACL, its location, and its role within the complete milieu of ligaments, muscles, cartilage and bones that form the knee structure. This description (and accompanying diagrams) should make very clear why jumping from various heights and distances might be expected to cause ACL injuries, thereby helping to build the rationale for the	. Thanks for the feedback. I have endeavored to add material to the introductory chapter to address your concerns.

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	experimental work to follow.	
2	. ***Duplication of review of literature material in papers 1 and 2*** – Although I understand that papers 1 and 2 were written for separate publication in academic journals, there is much overlap between the 2 chapters. From the perspective of the thesis document, I think the review of literature would be much better served if written as a single chapter. The 2 submitted papers could be included as Appendix material.	. Thanks for the feedback. In paper 1, to rationalize why new research methodologies are required, the challenges to understanding the mechanisms and risk factors to non-contact ACL injuries are presented. Further, the authors proposed a possible methodology to address many of these challenges. For paper 2, the goal is to bring awareness of two optimization approaches, i.e. OR and AI. The authors provide rationalization of why AI is better suited of the two approaches to address the challenges of non-contact ACL injury. But, what are these challenges. These challenges as presented in paper 1 had to be repeated to make paper 2 all encompassing, a standalone document and complete. So in order to justify the use of an OR or AI technique, the authors first needed to tell the story about the problem. The problem is why we still do not know how and why non-contact ACL injury occurs. Hence, there are repeats in the background information on the challenges to understanding non-contact ACL injury in papers 1 and 2. The authors presented tools available in the optimization world from both OR and AI communities that can possibly address these challenges. The authors went on to show why AI approaches may be appropriate to tackle the problem of how and why the ACL gets injured. This sort of proposed study methodology was absent from the literature, to the best of our knowledge.
3	***Possible lack of awareness concerning use of optimization techniques such as simulated annealing and genetic algorithms in the biomechanics literature*** – While reading the Introduction and paper 1, I was intrigued by the author's contention that present study approaches are inadequate and that he was proposing to use new state-of-the-art artificial intelligence (AI) tools and techniques. However,	. Thanks for the feedback. Please note that paper 1 and paper 2 are focused on the domain of ACL injury biomechanics and NOT the entire field of biomechanics. If we are to consider the entire field of biomechanics your claim may be accurate. At the time of writing the 2nd paper and to the author's best knowledge the only application – referenced in the thesis – of an AI technique to ACL injury biomechanics was by McLean et al. (Clin Biomech. 2004 and 2008). In the earlier paper (Mclean et al. 2004) only the word simulated annealing (SA) is mentioned. How the technique is applied to this study is not provided. Regardless, the authors use SA to minimize the difference (errors) between predicted and baseline muscle simulation data. Minimizing

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	much of the text was vague and lacking details. It was not until near the end of paper 1 (page 45) that I discovered that the AI tools include optimization techniques such as simulated annealing and genetic algorithms. Although the author may (or may not) be correct in saying that there are no non-contact ACL injury papers that use these techniques, simulated annealing is a commonly used optimization technique in the biomechanics literature, and has been for over 10 years. The tone and vagueness of the author's writing implies that these are new techniques that are at the heart of a new, integrated study approach that is better than those presently used in biomechanics research. I disagree, and wonder if this is poor writing, a difference in terminology associated with the author's background training, or is the author unaware that these techniques are commonly used in biomechanics research?	the difference in errors using an iterative search technique is a common practice in mathematics and has nothing to do with the study methodology proposed in paper 1 and paper 2. In a later study, McLean et al. (Clin. Biomech. 23, 2008, 926-936) provided more details into the application of SA to ACL injury risk prediction. However, the application of this technique by McLean et al. is exactly the same as mentioned above, and therefore is not as what is proposed in paper 1 or paper 2. Further, one would not be able to use this study to implement their own SA method given problem in McLean et al.'s 2008 paper is ill defined. In McLean et al. 2008 study the authors mention the objective function and variables but no constraints or constraints approach. Further, the authors used a fixed number of iterations as opposed to terminating the program against some test of optimality. Nonetheless, given McLean et al. 2008 applies SA to minimize errors between predicted and baseline muscle simulation data, it has no relevance to work presented in our paper 1 and 2. In this vain, we would like to ask that you highlight to us please the use of AI technique to the field of ACL injury biomechanics. In our paper # 1, the novelty is not in AI or OR techniques that have been existing for many decades, but in the application and how to apply an AI technique to address the barriers to our understanding non-contact ACL injury mechanics. Paper 1 presents a way using AI to fuse existing ACL injury study approaches into a single unified environment to better understand how and why the ACL gets injured. We kindly ask the examiner to show us a research paper that presents a paradigm that uses AI to fuse existing study approaches into a single environment with the objective to predict ACL injury. Paper 2 provides more details, awareness, and possible techniques from AI and OR communities that may be utilized in ACL injury research. Again, here the paper is focused on application of AI and OR to the study of non-contact ACL injury biomechanics, but not the entire field of biomechanics. What is exciting about paper 2 is that the research community is slowly beginning to realize that new research methodologies are required to understand ACL injury mechanics. These new approaches perhaps need to borrow from each approach given each approach on its own

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		has its own strengths but also limited in its ability to fully capture factors implicated to increase the likelihood of ACL injuries. So, the question then is how can we capitalize on the strengths of existing study approaches so we can more comprehensively and completely capture the problem of ACL injury mechanics. One possible tool to do this is optimization, more specifically AI. The authors also present a refined way to do this in the paper 2. You are correct that AI was applied to the field of biomechanics for decades, but not to non-contact ACL injury biomechanics, which is the focus of this thesis and both papers 1 and 2.
4	. ***Inconsistency between "gap" study described in papers 1 and 2 with subsequent experimental papers 3, 4,*** 5 – in papers 1 and 2, the author's viewpoint on currently used study approaches is clear. A main point of both papers 1 and 2 is that ACL injuries are multi-faceted, and current approaches that try to elucidate the role of a single risk factor are inadequate. In paper 2, the author describes a better approach that would incorporate multiple risk factors within a unified research approach. Because these papers formed the literature review that was to identify "gaps" in the literature and therefore provide the rationale for the author's doctoral work, I was expecting that the subsequent experimental and modeling efforts would follow this multi-faceted approach. However, papers 3 and 4	. The lack of funds, resources, skill sets, and support has forced the candidate not to pursue the development of the methodology. The development of such a methodology requires a research group with software, computing capability, and skill sets which was and still are lacking. To make Paper 1 and Paper 2 more easily publishable, the authors felt the need to add the element of a new research paradigm. This new research paradigm is something that is absent from the literature. You are correct that the existing approaches presently used in the biomechanics community were used in our research too, but this is within the limits of what can be done within the facility and resources available to the student. Regardless, paper 1 and paper 2 are reviews of the literature that expose many gaps in knowledge in the field of ACL injury biomechanics, and a possible way to address these gaps is the new research methodology proposed. The new research methodology was added to the publication to assist getting the paper published and arguably one of the most significantly contribution of this thesis.

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	use the typical biomechanics approach that the author had criticized in papers 1 and 2. Even in paper 5 where the author describes a MSM, it is used to further analyse the same conditions (and same experimental data?) as in paper 4, and not in the manner described in papers 1 and 2.	
5	. ***Lack of lateral and medial jump directions in papers 3, 4, 5*** – It is clear from the literature that one situation that puts the ACL at risk is movements that include a component in the medial-lateral direction in addition to anterior-posterior motion, such as "cutting" maneuvers during running. Why did the author choose to vary vertical height and anterior-posterior distance in the landing conditions, but not medial-lateral distance?	. There is no consensus in the biomechanics community that side-step cutting is a non-contact ACL injury mechanism (Quatman and Hewett, Br. J Sports Med, 43, 2009; Boden, Orthopaedics, 23, 2000, Olsen, Am J Sports Med, 32, 2004). The answers to the following questions are also not given yet in biomechanics community: Does valgus collapse cause ACL injury or valgus collapse happens as a result of the ACL being injured? At the vertical heights and horizontal distances studied, we conducted lateral jumps but did not include these in our studies given at some of the heights and distances studied some subjects were not comfortable performing these tasks. In addition, it proved challenging to ask subjects to jump on a single-leg from all these heights and distances so many times. That's why we did not include this way of jumping in our study. Medial jumps placed the subjects at great risk of injury due to inability to regain balance with this type of jumps, so it was not included in experiment. Further, medial and lateral jumps will likely lead to pronounced medial and lateral compartment forces which may lead to internal rotation of the tibia on the femur, which can dramatically increase the strain on the ACL (Markolk KL et al., 2005). In addition medial landings were seen as dangerous tasks for our study protocol given the increased risk of inducing high internal tibial rotations during this form of landing. Based on others' results, it is known that internal tibial rotations can increase ACL strain

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		(Arms SW et al. 1984, Berns GS et al. 1993) and also ACL force (Markolf KL 2005). It should also be noted that for this type of movement even though it is sagittal plane dominant, the abduction moment does play a role given the proximal femur is inherently abducted. The following papers looked at knee ab/ad for single-leg landings (Lawrence RK, Clin. Biomech. 23,6,2008; Nagano Y. et al., The Knee, 14, 2007; and Russel KA, et al., J. Athl. Training, 14,2,2006) and for double-leg landing (Decker MJ et al. Clin. Biomech. 18,7, 2003, Kernosek TW, Med.Sci. Sports Ex. 37,6, 2006, Chappel JD, Am. J. Sports. Med, 30, 2, 2002).
6	*.Incomplete description of results in papers 3, 4, 5* - The landing experiments that form the basis for papers 3, 4 and 5 will have produced a wealth of kinematic and kinetic data that describe the time-varying changes that occur as subjects prepare and execute their landing. However, the author has chosen to describe and present very little of these data. In the first of these papers (chapter 4), there are no time series data reported at all, making it difficult for the reader to appreciate how the subjects reacted to the different landing conditions. The only data reported are peak vertical and posterior GRF, plus values for some joint variables at	. Thanks for the feedback. Yes, there is a wealth of kinematic and kinetic data but selecting as well as processing the right data to support your objectives and arguments is a demanding and challenging task. The authors provided only the data in the journals to convey the objectives of each paper. So, given this is an article style thesis one needs to be selective in what best conveys the aims and hypotheses of the paper. Also many journals have restrictions on the number of figures and tables to include (e.g., Annals of Biomechanics and Biomedical Engineering maximum is 8), so even though there is a wealth of data it does not add more knowledge than what the authors already reported. So we chose to report data that best conveyed our objectives. We have added many time history plots to the thesis as per your suggestion. . The thesis focus is on risk of ACL injury. In the literature the way to establish risk is as done in this thesis, that is, a single point is used to establish study variables (dependent variables) implicated to cause injuries, for example, initial contact, peak VGRF, peak PTASF, peak knee flexion,

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	the time of these peak GRF occurrences. One variable was knee joint work, which is calculated by integrating the knee joint power curve over some time of interest (which is not described). How are we to interpret these single value data? Do these variables also reach their peak at the time of peak VGRF or PGRF? It is inappropriate to use that single value to represent joint motion during landing execution. For example, having a knee flexion value of -33 degrees (Table 1, page 94) at the time of peak VGRF does NOT indicate the degree of knee flexion during the landing phase; it is only one measurement from a time series of knee flexion angles. The date form the basis for correlations with VGRF (Table 2), and the correlations are then interpreted with statements such as (page 96) "*Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings.*" This is incorrect, as the author has not assessed the amount of knee flexion in each landing, only the knee flexion angle that occurred at peak VGRF. This "single	etc. For example, the following quotes taken from scholarly literature (keep in mind please that none of these studies measured ACL strain or modeled the ACL): a. "The results of this study show that the peak knee extension moment and peak proximal tibia anterior shear force are significantly correlated to each other. This result provides further support to the notion that proximal tibia anterior shear force and knee extension moment are indicators of ACL loading." (Yu B, 2006) b. "The results of this study further show that the magnitude of the peak proximal tibia anterior shear force and knee extension moments during landing of the stop-jump task are significantly correlated to corresponding peak ground reaction forces, especially the corresponding peak posterior ground reaction force. These results suggest that the peak ground reaction forces can be used to predict ACL loading conditions in future research and practice." (Yu B, 2006) c. "Hewett et al (2005) have shown that women tend to land with higher knee abduction moments (valgus torques), which are significant predictors of future ACL injury risk." (Boden B, 2009) d. "In the present study, subjects with strong hip external rotators demonstrated significantly lower VGRF during single-leg landing. This increased hip external rotator strength may provide insight as to why neuromuscular training studies have also been shown to decrease VGRF during landing (Hewett et al., 1999). The present study suggests that by improving proximal hip strength and thereby avoiding these poor landing styles the risk of ACL injuries to athletes could be lessened." (Lawrence 2008) e. "Landing with a more extended knee angle decreases the ability of the hamstring muscles to prevent anterior tibial translation, thereby increasing the risk of ACL injury. (Fagenbaum and Darling 2003)

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	value at time of peak GRF" is repeated in papers 4 and 5, and can lead to incorrect conclusions on any variable assessed. There are some time series data shown in papers 4 and 5, and some bar charts of gender-specific muscle forces in paper 5. In my opinion, more of these data should be reported in all 3 experimental papers.	f. We expected that women would land with more extended knees, potentially predisposing them to a greater incidence of ACL injuries. Arendt E. and Dick, R. Am. J. Sports. Med. 1995, Gomez et al. Am. J. Sports. Med.,1996). g. Limiting the valgus position of the knee during a single-leg landing could reduce strain on the ACL and in turn reduce the number of non-contact ACL injuries. (Russel 2006) i. "The finding of increase peak VGRFs in females is important as a previous prospective study of ACL injury risk demonstrated that athletes who went on to subsequently tear their ACL had 20% greater VGRF during a drop landing." (Schmitz et al., Clin Biomech, 2007) j. "Without sufficient strength available to decelerate the body by the eccentric quadriceps mechanism, it seems that the females land in a more extended knee position and tend to maintain this extended position subsequent to ground contact rather than absorbing the impact with controlled knee flexion. This knee extended position, combined with internal hip rotation, makes females vulnerable for anterior cruciate ligament loading." (Lephart et al. Clin. Orthop. Rel. Research, 2001). Note all of these studies are done in-vitro. In none of these studies was the ACL strain or force directly measured. In most if not all of these studies the risk of ACL injury was investigated. To the authors' best knowledge, this is the norm and has been the norm for the last two decades. Now, if you randomly take any reference from this thesis in the domain of ACL injury biomechanics, you will observe the similar style inferences being made. The authors would venture to argue the same argument can be made about any other injury mechanism studied in the domain of ACL injury biomechanics.

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		We have added many time histories plots for many dependent variables. Also please keep in mind that many journals have limits on number of figures and tables that can be included. So, the observation of body kinematics, muscle and joint forces, and external forces as well as their interactions may help us determine how the body responds to safely reduce the impact forces. Hence, ankle, knee, hip or trunk flexion at time of peak VGRF with increased task demand may inform us as to how the body responds to these demands to attenuate impact forces and subsequently risk of ACL injury.
7	***Incorrect interpretation of at least some correlation data in papers 3, 4, 5*** - At least some of the correlation data in these chapters have been interpreted incorrectly. For example, in paper 3, peak PGRF data are plotted as a function of horizontal distance jumped in Figure 2, page 95. Notice that on the vertical axis, the PGRF values are all negative, which is an indication that the posterior direction has been assigned to the negative, while the anterior direction is positive. Further, notice that as you scan across the graph from lower horizontal distances (30 cm) to higher ones (50 and then 70 cm), the PGRF values INCREASE in magnitude (from ~-0.6 to -0.8 for the mean).	. Thanks for the feedback. Your comment of correlation between PGRF and horizontal distance is correct. We have corrected this as well as rechecked all other correlations to ensure accuracy. Using a lumped mass approach and basic mechanics will confirm the accuracy of the above statements (see attachment B). Landing as seen in this thesis is 3D, includes multisegment kinematics, and most importantly includes the muscles that all work together to dampen the loads on impact. How the body dampens these impact loads is one of the mandates of this thesis. I think that just considering a lumped mass approach for single-leg landing then employing Newton's law is not a true strategy. As well, our system is not closed with respect to the momentum and energy transfer. Thus, just simply using a rough, say, conservation of linear momentum between the beginning and end of a landing trial does not seem to be correct.

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	Because of the negative values assigned to the posterior direction, this forms a negative slope on the graph, and the author reports this negative correlation as *"The other significant finding of this study…"* (page 93, in Results). However, the author mis-interprets this negative slope when he states on page 97 *"Our results …… there will be a REDUCTION in peak PGRFs for landings performed at increased landing distance"*. This is particularly troublesome for the GRF data, as this statement of reduced horizontal force with increased jumping distance runs contrary to Newtonian physics: with increased horizontal jump distance, the horizontal take-off and landing velocities MUST increase, and the horizontal landing impulse (force X time; area under the force-time curve) MUST increase to bring the horizontal velocity to zero upon landing. One would expect the peak PGRF values to also increase in magnitude (as they do), although it is possible for the impulse to increase but not the peak PGRF. This level of mechanics knowledge should be well within the capability of a doctoral student in biomechanics. The author should carefully check	

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	the interpretation of ALL correlations, especially ones that include positive or negative signs that indicate direction (e.g. force vector components, joint angular velocities, joint moments).	
8	.*Incomplete description of subject population(s) in papers 3, 4, 5* - In paper 3, there are 6 male subjects. In paper 4, there are 6 male subjects and 5 female subjects. Are these the same male subjects in both studies? Are the data from paper 3 and 4 from the same experimental data collection, or form 2 different data collections? In paper 5, there are 3 male and 3 female subjects. Are these a subset of the subjects in papers 3 and 4? Why is EMG data only reported for the 6 subjects in paper 5? If any of the subjects / data are the same in the 3 papers, this should be noted when describing the subjects in papers 4 and 5.	. Are these the same male subjects in both studies? Yes Are these the same male subjects in both studies? Yes Are the data from paper 3 and 4 from the same experimental data collection, or form 2 different data collections? Yes, same experimental data collection. In paper 5, there are 3 male and 3 female subjects. Are these a subset of the subjects in papers 3 and 4? The 6 subjects are a subset of the subjects in papers 4. Why is EMG data only reported for the 6 subjects in paper 5? EMG data was recorded for the purpose of MSM validation. If any of the subjects / data are the same in the

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		3 papers, this should be noted when describing the subjects in papers 4 and 5. . This has been done. Be aware please, however, this is an article style thesis and these manuscripts are very separate papers with different objectives, hypothesis and methods.
9	***Poor statistical power in papers 3, 4, 5 due to small subject numbers*** – In the 1970s and 1980s, it was normal for biomechanics studies to have relatively few subjects due to the tedious and time consuming data analysis procedures (cinefilm methods with hand digitization, force plate data needed to be carefully synchronized, and all data reduction and analysis performed with custom written software). However, in the past 20 years we have seen the advent of automated motion capture systems which seamlessly integrate time synchronized kinematic, kinetic and EMG data, and off-the-shelf 3D analysis software (e.g. Visual 3D) and MSM software (e.g., OpenSim, AnyBody). With this improvement in data handling we have seen larger numbers of subjects in biomechanics studies, which brings greater statistical power. Why are so few subjects used in the studies described in papers 3 and 4, and particularly in paper 5? Did the	. From the ANOVA studies conducted the high F values indicate that we have more subjects that we really need. In fact for paper 3, we could have easily used 3 subjects and get high F statistics and powers. From work of Cohen et al. (1988) acceptable powers are assumed to be above 0.8. There are many studies in the literature where powers below 0.5 are published. However, your point may be valid for PPMC even though data reported does not substantiate your comment here as well. Recall Pearson correlation is not a robust analytical tool as ANOVAs. For Pearson correlations, we are trying to develop a regression equation to enable us to make predictions to any other conditions and for any subject. It is harder to get high coefficient of determinations with such small population size. Nonetheless, our data does not entirely show this. Our data does reveal significant findings for PPMCs for studies conducted. Paper 5 is a musculoskeletal modeling effort and not experimental effort whose purpose was to develop, validate and apply the models to experimental data to get the internal forces. We are still to see a MSM study applied to non-contact ACL injury mechanics that employ more than 6 subjects. We did not perform *a priori* power analysis.

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	author perform a statistical power test *a priori* that suggested such low subject numbers?	
10	***.Incomplete description of MSM in paper 5*** - In paper 5, the author uses subject-specific MSMs to predict the forces in internal body tissues. However, the model is not described in sufficient detail, with only general statements used such as *"The GaitFullBody MSM was ... individualized for each subject"* and *"... the model is made subject-specific by employing a length mass fat scaling algorithm that uses the anthropometric data measured for each subject to scale the MSM"*. What data are used as inputs to the model? What anthropometric measures were used in the scaling? How many muscle models are included in the model? Are differences in individual subject joint strengths (measured with a dynamometer), or muscle morphology (from MRI or ultrasound) included in the subject-specific models? Were the muscle model force-velocity, force-length and elastic characteristics subject-specific? Was the force plate data used as input to the model, or did the model include a foot - floor interface that would generate GRFs as model	. Thanks for the feedback. The paper was changed to address all your concerns so as to better describe the model. Are differences in individual subject joint strengths (measured with a dynamometer), or muscle morphology (from MRI or ultrasound) included in the subject-specific models? .The answer is no. A simple muscle model was used that assume constant strength. Was the force plate data used as input to the model, or did the model include a foot - floor interface that would generate GRFs as model outputs? . Force plate and kinematic data from experiment were used as inputs to the musculoskeletal model. Was there an objective function that was optimized? Were there constraints on the solution? How were they imposed, as "hard constraints" or as penalty terms in the objective function? Which optimization algorithm was used (e.g. simulated annealing)? There are two modelling process and models in the development of the musculoskeletal model. First model is a kinematic model that matches the motion capture marker data from experiments with the rigid body model in

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	outputs? How did the MSM generate its muscle model activity timing as seen in Figure 2? Was there an objective function that was optimized? Were there constraints on the solution? How were they imposed, as "hard constraints" or as penalty terms in the objective function? Which optimization algorithm was used (e.g. simulated annealing)? A much more complete description of the MSM and how it was tailored to each subject is needed.	AnyBody "the man". This is a kinematic optimization process whose objective function is geared towards minimizing the distance between markers from experiment and model "the man". In doing this, the man becomes scaled to the person anthropometry in experiment. The optimization process stops when there is an acceptable level of error that is set by the user. For further details of the optimization routine (by no means AI based) please see (Andersen et al. 2009). The Second model is an inverse dynamics model. This model uses a min/max objective function (Rasmussen et al. 2001). The basic optimality assumption is that "the body attempts to use its muscles in such a way that fatigue is postponed as far as possible". Hence in our optimization problem we would minimize the maximum muscle activity subject to equilibrium constraints and positive muscle force constraint (muscles can only pull). AI methods are not employed in AnyBody. The software uses Newton Raphson methods for the kinematic problem. It then uses the golden section method for inverse dynamics. How did the MSM generate its muscle model activity timing as seen in Figure 2? Details of the mathematical and mechanical methods of the AMS software are described in the literature and referenced in the paper. Please consult the following references: (Damsgaard et al. 2006; Rasmussen et al. 2001)
11	***.Use of gait data in model "validation"*** - In paper 5, the author describes the use of *"gait data collected during our study"* for purposes of validation. What gait data were collected (none was described in the experimental procedures)? Was it for the same	. Thanks for the feedback. The details of the walking gait trials collected from the same subjects prior to the single-leg landing tasks was added to the thesis. Yes, the same subjects that performed the single-leg landing task performed the walking gait task. The subjects were asked to walk naturally without accelerating or decelerating while dominant leg strikes the force plate.

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	subjects? Running? Walking? What was the progression speed? Was the gait at constant speed, or were the subjects accelerating or decelerating? Were the foot – floor interface parameters the same for gait as in single-leg landing? Should they be? And even if the gait model results were compared to literature values as in Table 1, how do we know the MSM will be valid in an impact situation with sudden deceleration such as in single-leg landing? In the absence of a comparison between model and experimental data from the single-leg landing trials, I am unconvinced that the model should be considered validated as the author states. How well do model kinematics match experimental kinematics? How well do model GRFs match subject GRFs? Did the author perform a sensitivity analysis to see which model parameters have the largest impact on the model results?	Were the foot - floor interface parameters the same for gait as in single-leg landing? Should they be? .The foot-floor interfaces was identical for the single-leg landing task and walking gait task. We are not sure why they should be different. Any difference would need to be reflected in the MSM, as well as data used for validation which most likely does not exist in the literature. And even if the gait model results were compared to literature values as in Table 1, how do we know the MSM will be valid in an impact situation with sudden deceleration such as in single-leg landing? . This is a very good question. The answer is: we do not know. However, the model used from this study is a Gait full body model, which is the most heavily worked on model in the Anybody repository with over 10 years of development. This model was extensively verified and validated by other research groups for gait. Outside of this to apply this model to our application we did various things to acquire confidence in the model such as sensitivity studies, comparison of outputs with Visual 3D and muscle modeling studies. Again, given this is an article style thesis this information was not added to the thesis given it was deemed unworthy of publication. The validation process used in this study is two-fold. First, we compared EMG measured with muscle activity from model. This is the classical approach and only approach used by many MSM studies. We have added time histories of measured versus predicted muscle activity, as well as the mean correlation coefficients of muscle activation measured versus predicted for 8 muscles. To acquire greater confidence, we went a step further with our model and endeavored to compare model predictions with *in vivo* data of knee joint reaction forces and moments during single-leg landings. Unfortunately such data does not exist. However, given *in vivo*

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		data on walking gait exist, we compared our model predictions with this. Given the efforts from above, we were given some confidence that our model is valid. In the absence of a comparison between model and experimental data from the single-leg landing trials, I am unconvinced that the model should be considered validated as the author states. How well do model kinematics match experimental kinematics? How well do model GRFs match subject GRFs? Did the author perform a sensitivity analysis to see which model parameters have the largest impact on the model results? Validation of models demands experimental data for confirmation. Such data are difficult to record and in many cases may never be obtained. As a paradox, this is actually the reason why models are developed in the first place. The validation of this work was to demonstrate that model produces reasonable estimates for muscle activation patterns during single leg landing, as well as joint reaction forces during walking. To date *in-vivo* experimental data on single-leg jump landing does not exist. It is not currently possible to fully validate MSMs since the data necessary to provide the validation would be too invasive (e.g., strain gauged tendons, ligament etc.). This study has attempted to validate the model using EMGs and comparisons with published *in vivo* studies having similar experimental conditions. This study used the best means currently available. We provided two separate comparisons for validation. The comparison of muscle activity from model with experiment is quite within what would expect from these sorts of model. For the most part this is the fullest extent to knowledge provided for model validation in the literature. Further, we are convinced that our results in table 1 would be better if the subjects from *in-vivo* studies and that from experiment were closer in weight. For the *in vivo* data subjects were at least 300N heavier that the average subject weight from our study.

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		The matching of model kinematics with experimental kinematics was within an error less than 0.5. This means the total difference between markers from experiment and markers from the model for all markers is less than 0.5 at the end of the optimization process. See sample output from objective function optimization (please see Attachment A). GRFs are used as inputs via the C3D file and unchanged in AnyBody. We performed many sensitivity studies – please see summary report (report 4), which includes studies on muscle recruitment criteria: Report 1; muscle model type (simple vs. hill): report 2; and, study to verify the large joint reaction forces and moment from developed AnyBody model: report 3.
12	• ***Omission of knee ligaments (including ACL) in MSM*** – In papers 1 and 2, the author champions the use of MSMs that will allow the estimation of internal forces acting on tissues within the body, important data that cannot be measured due to ethical considerations, and cannot be computed by standard rigid body inverse dynamics models. In paper 5 the author describes the use of a MSM, but I was very surprised to find that the MSM did NOT include the ACL, which of course is the main topic of the doctoral thesis. Why was the ACL (and the other 3 major knee ligaments) omitted from the MSM? Given the title and topic of the thesis, what was the rationale for leaving the ligaments out of the model? Surely the force (stress) and	The material properties, geometry, and constitutive law to model the four major ligaments of the knee joint is unknown or under research. The kinematics of the ACL during single-leg landing is also unknown in the scientific community. As well, ligament-bone and ligament-ligament interaction is unknown in the scientific community. The author is aware that 1D line elements can be used to model the ligaments, but this would be nothing more than a constraint (like a muscle) added to the joint to balance external forces. It seems that one dimensional assumption may be acceptable given that *in vivo* data to date on soft tissues such as the ACL are limited to force or displacement measurements. Almost all mathematical models developed to date for the knee use one-dimensional representation for the ligaments. This is mainly because of the belief that the primary function of the ligaments is to resist tensile forces. Although one dimensional representation can be used to predict ligament forces, they are unable to predict stress distributions.

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	strain that the ACL undergoes during the landings would be a valuable addition to the thesis?	
13	***.Data for males and females not reported separately in paper 5*** – In paper 5, the data and correlations in Table 3 are reported for all 6 subjects in aggregate, even though the purpose is to compare the male and female groups. The separate male and female data should also be reported, and indeed are the critical data needed to compare between male and female responses.	. Thanks for the feedback. All variables for males and females have been added in the thesis in two separate tables to facilitate comparison.
14	**.Contribution of the thesis to advancing knowledge:** This is difficult to judge until the data in papers 3, 4 and 5 are described in more detail.	More details have been added to the thesis as requested.
15	. **Research methodology:** The motion capture, force measurement and EMG data collection techniques used by the author are well established in the biomechanics community, as are the use of rigid body inverse dynamics models and musculoskeletal models. Due to lack of written detail, it is difficult to know whether the musculoskeletal models are really "subject-specific" as the author claims, and it is difficult to know how well these models represent the subject movements during the single-leg landing tasks. I do believe that the studies are under-powered due to low subject number.	. For each subject, musculoskeletal model was individualized so that model anthropometry matches subject anthropometry through a scaling law. This law is described in the paper. The inputs to facilitate scaling are subjects' body weights, heights and in some cases their segment lengths were adjusted. The later is done when the objective function residual from the kinematic modeling process yields high errors, which brings us to your second comment. To judge how well the kinematics from subjects matched model kinematics, an optimization routine was conducted. This process involved matching all markers measured by experiment to markers from the model. An error of below 0.5 or 0.1 is acceptable (see Attachment 1). In some cases, this is hard to achieve because of quality of data recorded in experiments.

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		. The study is not underpowered based on statistical ANOVA data reported. However, for the correlation studies we may have been able to obtain higher coefficient of determination and significance in areas where no significance was observed in our study.
16	**.Analysis of results and value of conclusions:** As described in the **General Comments** section above, the data in papers 3, 4 and 5 are not described in sufficient detail. This makes it impossible to fully understand the results of the experiments, and therefore the value of the conclusions. In my opinion, there are incorrect interpretations of at least some of the correlation data presented, leaving to some incorrect conclusions.	. This has been corrected throughout the thesis after many sit downs with Statistics professor from the school of human kinetics.
17	. As described in the **General Comments** above, I have major issues with the lack of detail in the material presented in papers 3, 4 and 5. I also think that chapter 7, currently titled "Discussion", would be better described by a title such as "Summary and Future Studies". As it stands now the chapter is not really an integrated Discussion of the thesis findings, but rather a serial summary of each of the 5 papers, followed by recommendations for future research. If it is to retain its current title, the chapter needs substantial revision to include integration of the important aspects of the different papers that is not present in the separate chapters themselves.	. Chapter 7 has been re-titled in the thesis as you suggested.
18	To accomplish this a problem is defined and formulated to determine the instance where many risk factors, many forces, and other extreme conditions happen simultaneously to	Thanks for the feedback. The answer is: we do not know, however, we can speculate that given the MDO paradigm can handle large-scale problems and take a global look at the problem, we may better be equipped to pinpoint the key factors contributing to injury and more importantly better understand the cause of the injury.

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	cause ACL failure. In the model how do we know if this will occur in any human?	
19	Kinematic data were low-pass filtered using a second-order bidirectional Butterworth filter at 6 Hz and analog data were filtered at 25 Hz. Why these cutoff frequencies?	. Kinematic data filtered at 6 Hz and force plate data at 25 Hz worked out well. We did tests to ensure these frequencies did not alter the raw data significantly, and retained a high percentage of the original signal content.
20	Page 99 on paper 3: Need to evaluate joint flexion, power and work over the entire time course of landing - not just one specific instant	. We are not sure how one will go about looking at knee flexion over the entire landing cycle to determine risk of ACL injury. Most studies assess kinematics, kinetics and energetics at a single point in time such as initial contact, peak VGRF, max knee flexion, etc. We specifically looked at one instant of time given it has been shown that the time of peak VGRF, for example, is the time at which peak ACL loads occur.
21	The results and discussion stemming from this study are only based on the theory of what is known about the relationship between ACL loads and GRFs. What does this mean.	.This means that peak ACL load occurs at the time of peak VGRF or some other peak value such as peak PGRF. For example, one in-vivo study that showed peak ACL load occurs at the same time as peak VGRF used only one male subject that performed a single leg hopping task. This is why all kinematics, kinetics and knee energetics were selected at time of peak VGRF. This approach is to assess risk of ACL injury and hinges on the validity.
22	Paper 4: Why knee abduction moment?	. The literature has shown that knee abduction moment may also predict the risk of ACL injury (Hewett et al. 2005; Markolf et al. 1995).
23	Paper 5: How were subject specific muscle characteristics assessed.	. The MSM was made subject specific via scaling the anthropometry. The muscle characteristics were not made subject specific as this is not an easy task. Throughout this study, a simple muscle model using constant strength was used. The muscle strength of each subject was not measured during experiments. Note throughout the paper the word "subject specific" was removed and replaced with individualized.
24	Joint reaction or bone-on-bone?	.The joint reaction force will have a component of bone-on-bone contact

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		force. The reaction forces come out of the equilibrium equations and will have all components of the externally applied loads from gravity, the load from GRF, reaction forces from other joints, and forces from muscles. .Also we have modeled anatomical joints with simplistic idealized joints, for example, hinge joint for the knee, the reaction forces in this case represents what must be carried by the joint bone-on-bone contact and the soft tissue structures. In our model, we have a representation of the net loads in the joint and the direction of this load.
25	Vague how MDO does it work.	. We have added details to the thesis to explain this further. Keep in mind that the AI technique used in the MDO approach proposed is a black box as shown in Figure 2 of Paper 2. The AI technique functions to fuse existing ACL injury study approaches. We have added details on page 45-46 on how this can be done using OLE or DDE.
26	The AI technique is employed to orchestrate the fusion of the two quantitative study approaches in the MDO paradigm, as well as, to facilitate search and parameter identification. Commonly done in Biomechanics.	. Please provide a reference that shows where/how this is done in the field of biomechanics or more specifically, as per thesis topic, in the field of non-contact ACL injury biomechanics.
27	In this approach, the three qualitative study approaches are used for results validation. How? An AI technique also enables one to capture the wide variability in movement patterns to cause injury, and in tissue material properties, numerous design variables, numerous design constraints, many risk factors, and multiple objective functions. How? Vague	. Greater details have been added to pages 45-47 on how this can be done. The final figure provided in papers 1 and 2 also provide details on how to do this.
28	It is hypothesized that increasing height and distance of landing	. We believe it is a real hypothesis. For a non-living system such as an inanimate object, we would certainly agree with you, however the human

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	increases both the peak VGRFs and the peak PGRFs. Is this a real hypothesis? Doesn't Newton's law of acceleration predicts this?	body has muscles and the kinematics (landing technique) to dampen the loads from impact, even as vertical velocity and angular moment, increases. So, even when you increase height or distance, the ground reaction forces may not necessarily increase linearly as per Newtonian mechanics because the body aims to attenuate these forces. How the body does this is one of the aims of our study. Also this is a real hypothesis since we're dealing with a dynamic moving multisegment structure, in which each segment's acceleration and consequently motion is being produced by various muscles and also is being controlled quite case dependently. So, making a conclusion just based on Newton's 2nd law is practically underestimating our problem and does not seem to be a logical way to go.

Regarding you comments, we also could find no ISB standard for the knee joint. Further, many of the standards issued by ISB are not followed or more importantly enforced by scholarly publications, governments, university or industry.
ISEK standards for reporting EMG data is a good reference, thank you.

PhD THESIS REVIEW SHEET for Examiner C	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

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1	. While the sample size for the experiments is small, the results achieve statistical significance (for the population segment tested) and perhaps more importantly, partially illustrate the multifactorial analytical approach proposed by the candidate.	. The population of subjects studied were weight and height matched as much as possible. However, due to limitations of equipment and poor calibration of both the force plate and EMG system some of the subject data could not be used given force plate saturation and EMG system not working. Further, the test protocol had to be adjusted to remove the number and types of jumps performed by the subjects. Several subjects were added to papers 3 and 4 to increase statistical power. Tests show high powers were achieved.
2	The results are mostly properly described and analysed throughout the dissertation. Clearly, the most interesting material with regards to analysis of experimental data is contained in Papers IV and V. However, there is some	The results from papers 3, 4, and 5 were drawn from the same sample of subjects. A study by Louw and Grimmer titled "Biomechanical factors associated with the risk of knee injury when landing from a jump" (SAJSM Vol. 18, No 1, 2006) showed that only 8% of studies justified sample size used. Over 50 % of the studies included less than 20 subjects and the average age of subjects in all studies was 23 years. This study also

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	discontinuity in the results shown in both papers, although these results were assumedly obtained from the same set of experiments. This will deserve explanations during the oral defense and will likely justify revisions of the dissertation.	showed that males were more frequently studied than females. The authors using this as guidance and the feedback from committee members during the thesis proposal stage felt a sample size of 16 was sufficient for our objectives. Recall, initially the thesis proposal included only 6 subjects. No a prior power analysis was conducted. However, given force plate saturation and poor EMG data recorded some subjects data was removed from analysis.
3	. The organization and writing style of the material are acceptable, but would benefit from serious polishing and rewording/shortening of many unduly long and complex sentences. Many typos were also spotted. Many figures, graphs and tables are too small or too crowded a problem that needs to be addressed.	The figures and tables throughout the thesis were revised to make clearer. Further, many more time history plots, figures and tables were added based on recommendations from the external examiner.
4	Para 7: Paper IV essentially repeats paper III and goes further. Therefore, one should consider the deletion of Paper III for conciseness.	Paper 3's scope looks only at male subjects without a concern for gender effects. There is a high disparity in the ACL injury rate between genders. Why this disparity occurs is what paper 4 tries to understand. Paper 3 is focused only on height and distance effects on body kinematics and kinetics as well as knee energetics. Hence, the questions answered in paper 3 are very different from that in paper 4 although the experimental method employed is identical between the two papers. Given the dearth of information on knee energetics during single-leg landing from increasing heights and distance of landing, it was felt more effective report the results from our findings in separate papers.

PhD THESIS REVIEW SHEET for Examiner D	
Document Title: Predicting risk factors of non-contact anterior cruciate ligament injuries during single-leg landing	
Revision: Final	
Author: Nicholas Ali	
Date Submitted:	
Related Docs/Reference: Four examiners reports, Original PhD Thesis and Revised PhD thesis	
Date Evaluated:	

Examiner D.

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
1	. Revise paragraph format	It is unclear to us what change is required here.
2	. How much of the predictive nature of ACL injury is random and how much is predictable?	To date the answer to this question is unknown in the scientific community (please consult for example, Renstrom P. et al. BJSM, 2008, and Davis I.M. and Ireland M.L. 2001, Clin. Biomech.).
3	.The term "risk factors" is often used in a manner that leads the reader to question the appropriate use of this term. For example "To accomplish this a problem is defined and formulated to determine the instance where many risk factors, many forces, and other extreme conditions happen simultaneously to cause ACL failure." In my mind this includes environmental factors (ice, etc), footwear, medication, range of motion, balance, etc. More precise	"In my mind this includes environmental factors (ice, etc), footwear, medication, range of motion, balance, etc. More precise terms would be useful in many situations within the thesis." If this is what is in your mind, then the use of the term "risk factors" did not mislead you as all factors you have mentioned above are indeed risk factors. As highlighted in the thesis, there is much lack of agreement and confusion on risk factors implicated to cause injury, as well as how to categorize them. The risk factors may be categorized as biomechanical, environmental, anatomical and hormonal variables (Griffin et al. 2006; Renstrom et al.

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	terms would be useful in many situations within the thesis.	2008). Many studies have concluded that these risk factors are responsible for non-contact ACL injuries, but a large number of them have focused only on one or a few risk factors, thereby failing to capture all factors at once, as well as simultaneously considering the interactions of the different risk factors involved.
4	. The first two papers try to build a rationale for an ACL research methodology, but this method was not used in the thesis. Therefore, should these papers be included in this thesis?	The first two papers are review papers that endeavored to first highlight the barriers to better understanding the mechanisms and risk factors of non-contact ACL injury. From this review, the authors aimed to identify gaps in knowledge related the field of non-contact ACL injury. The authors went on to publish this work given many gaps in the literature identified can be used to steer future research direction. The authors tried to frame this review of the literature with the aim to bring some new insight and directions to this specific topic of research. Secondly these papers proposed a study methodology that may enable one to overcome the barriers to non-contact ACL injury research, hence its scientific contribution. To the authors' best knowledge, this information is absent from the literature. The details of this methodology is further elaborated upon, so that other researchers with larger budget, equipment, skill sets, and other resources can gain from this and perhaps employ it. The difference in the two papers' proposed study methodologies is that one is more refined than the other. This is a natural process of learning and development. Moreover, while many research groups have suggested that a multifactorial/multidisciplinary approach is required to address the challenges of non-contact ACL injury research, none of them has yet proposed a study methodology to do so. Thus, we think that these two papers are appreciable contributions to science. The authors offer the following email from a renowned researcher in the field of non-contact ACL injury research to the corresponding author on his views of Paper 1. Please note that Dr. Hashemi's work

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		was published after Paper 1 was published.
5	.Plantiflexion should be changed to plantarflexion throughout the document	Plantiflexion has been changed to plantar flexion. Plantarflexion is not in dictionaries.
6	.The word "gleaned" is used in the thesis. This can be changed, since the information is usually not "extracted from various sources" or "collected gradually and bit by bit"	We respect your point, but please note that various sources were indeed used, and hence word usage seems quite valid and logical.
7	.BW may be in N for paper 3 and Kg for paper 4 (Nm/BW*h). Please check and be consistent.	Please note that in both papers 3 and 4 forces were normalized to BW. So, we are consistent. In paper 4, the moments were normalized by the product of body mass and body height. We have stated BW* H, and this is incorrect as you have pointed out, so it has been corrected in all tables in paper 4. Thanks for your constructive comment.
8	.Do not replace commas with dashes. For example. "statistics -not presented- one can observe" should be "statistics, not presented, one can observe"	Thanks, change has been made throughout.
10	.Since arms motion was removed from the task, this should be considered with discussing the results	We think that this should have been suggested and discussed at the proposal stage, but not now. A point has been added to paper 3 through 5 to address this comment. In an effort to minimize the effect (variability due to swinging arms), the arms position during the single-leg landing task was standardized. The hands remained on the iliac crest throughout the landing task to remove the variability in landing mechanics due to swinging arms. Any reduction in the variability that can be obtained will result in greater statistical power and therefore reduce the probability of

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		committing a Type II decision error. The lack of standardization in the tasks (i.e. allowing swinging arms) may invalidate meaningful comparison. Subjects were not given any special instructions with regards to their landing mechanics to prevent experimenter bias. Further, the mass of the arms are small in comparison to the rest of the body, therefore their contribution to joint moments and forces are most likely negligible.
11	In paper 3, .Results must be clarified to indicate which results are linked to vertical, horizontal, or individual height analyses. .Results must be shown in tables for each height and distance condition (mean and SD)	. Change has been made to further clarify test for vertical height and test for horizontal distance in the thesis. See pages 95 and 96 please. . Tables with all means and all SD have been added to page 94 as well as other tables.
12	In paper 4, .The introduction talks mainly about the lack of literature but does not discuss the outcomes from the literature that does exist. This section needs to be rewritten to provide the reader with an overview of the existing literature on gender differences with single leg landing. This should cover both drop landing and jump to single leg lending since both topics are relevant. You can also discuss the	. Paper 4 clearly states that the study of single leg landing over increasing heights and distances that relate findings to risk of non-contact ACL injury is absent from the literature. Therefore this did not allow us to directly compare our findings with the literature. In the discussion, we highlight studies that look at a single height of two heights or compare single and double leg landings. . This comment should have been made at the thesis proposal stage. Please note that this thesis covers just single-leg landing, as was discussed and approved in the thesis proposal defense.

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	overall findings studies on just males and just females studies. .What post-hoc statistical tests were used to support statement of significance in the results (ex., Females had significantly less ankle plantiflexion angle than males)? .Post-hoc analysis is needed to explore the differences between conditions and groups .What range was used for the work outcomes? .Bring all mean and SD outcomes into one table (easier for the reader to examine outcomes).	Thank you for the feedback. At the thesis proposal stage a prior power analysis was not conducted. However, previous studies in literature such as the one provided to you at the thesis proposal defense (Louw Q and Grimmer K SAJSM 2006) that aimed to justify the sample size used for the thesis at the time (i.e. N=6) was provided. What was the outcome of this effort? Please be aware that the three papers in the thesis provides N, p and eta. Eta is a good measure of the degree to which the null hypothesis is false. Based on advice from supervisors, post-hoc studies were not conducted. However, at the thesis proposal stage similar studies on single-leg landing were reviewed to query subjects used and possible power. The total number of subjects selected initially was 6, and this was later changed to 16. . This is a good question. Work was calculated as the integral over the entire power curve from start to end of the task. The decision to use the entire motion was based on the idea that the negative power curve represents energy absorption by the extensor muscles (McNitt- Gray, 1993), thus it would allow a better representation of muscular energy absorption during the entire task. . This change has been made. All values consolidated into one table (Table 3 on page 129) except those influenced by gender of which figure 7a and 7b were added. . Tables fonts are larger. Necessary changes have been made throughout the thesis as requested.

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	Includes table 2, 4,6 .The font size is small. Tables could be revised if font size can be increased, but put these revised tables beneath each other in the manuscript. .It would be useful to have female, male, and overall mean and SD data presented, since the focus of the paper is on gender differences	.We think that these tables are not required as statistics revealed no differences between males and females except at ankle angles. For this, the means and SD were provided.
13	Paper 5: .See Kernozek, Torry, et al (2005) .Various aspects of the validation steps on pages 128-129 are unclear. .Specifics of the subjects, data, and activity used for Anybody input should be presented. .This section combines methods and results. Separating these may help to solve the confusion for the reader.	.Paper by Kernozek et al. is for a double-leg landing from a 60 cm height only while subject is hanging from a bar. We do believe no comparison is permissible with the findings of this paper. .Please let us know what is unclear. .Throughout the thesis all the sections has been revised to capture your requested changes. .Thanks for the feedback. Change has been made on page 130 to 131 to make this clear.

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14	.Page 24: "This work also appraises the methodological rigor"	.This change has been made on Page 24.
15	.Page 25: revise "has been somehow patchy"	.The authors believe that it is OK and so no change is required.
16	.FaunÃ is mispelled, check foreign language character sets.	.Thanks- change made FaunØ.
17	Page 27: ."side step cutting maneuvers, to name a few" ."view of ACL injury mechanisms"	. Both changes have been made on Page 27.
18	Page 29: "McConkey (McConkey, 1986) was the"	.This change has been made on Page 29.
19	.Page 30: "As well, muscle activity across the ankle controls the position of the foot at landing, which most likely influence the loading at the ankle" .As well, muscle activity across the ankle controls the foot position at landing, which most likely influences ankle loads.	. This change has been made on Page 30.
20	.Page 35: "Another, non contact method includes optical" .Rearrange paragraph to group contact and non-contact items	. This change has been made on Page 35.
21	.Page 37: "Computational modeling has become popular partly"	. This change has been made on Page 37.

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22	.Page 37: Remove "(see for instance"	. This change has been made on Page 37.
23	.Page 39: Reword "ACL injury research is a multidisciplinary field, since one need to consult with many disciplines in a single problem"	. This change has been made on Page 39.
24	.Page 25: "Nonetheless, the prevention of sport related noncontact ACL injuries today relies largely on the ability to screen at risk individuals and then modify through training the identified risk factor." .Screening for being at risk of ACL injury is not a common practice (i.e., foes not "rely largely upon) .Appropriate ACL at risk screening tools are not available	.Please let us know what you mean here, as it is unclear to us.
25	.Page 26: "are among the risk factors that can be modified through training" .Listed items are not risk factors	You are correct. Sorry for the mistake. Sentence should read: "Neuromuscular control strategies and muscle strength are among the risk factors that can be modified through training (Ageberg 2007; Bryant et al. 2008; Myer et al. 2007). Change has been made on Page 25-26
26	.Page 26: What is "hand searching", reading paper copies of journals? What journals were reviewed?	At the University of Toronto, most journals can be accessed hard copies at the library. Journals in the domain of bio, or bioengineering are catalogued this way and hence were viewed this way. Specific names of these journals are among those referenced.

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27	.Page 27: How did you determine that computing power was an obstacle for these studies? The choice to use slower computers does not mean that other computing options were not available.	Please read the sentence below from Page 27 which motivated this question and comment. "Fragmentation and discrepancies in the literature may be a reflection of the limitations and differences in current non-contact ACL injury study approaches which includes but not limited to, equipment used, computing power and software programs." Please let us know if we need to make further clarification.
28	.Page 27: What are the "the associated contributing risk factors"? What about the target activity and environment?	The associated risk factors can be broken down into four groups: environmental, biomechanical, neuromuscular, and hormonal (see Griffin et al. 2006). The activity is captured under kinematics and external loading, while the environment (e.g. playing surface) is a risk factor.
29	.Page 30: "that foot contact with the ground is an important risk factor in non-contact ACL injury" .Soccer players make foot contact with the ground with each step, typically without injury, therefore this risk factor statement should be reworded,	.Thanks for the feedback. Sentence has been amended on Page 31: By one study conducted using soccer players with varying cleat designs, it was also shown that cleats that produced higher torsional resistance with the ground is associated with higher risk of non-contact ACL injury (Lambson et al. 1996).
30	.Page 31: "ground reaction forces (GRFs) cannot be transmitted effectively through the **bones to the ground**" .GRF vector is from the ground to the foot	.Thanks for the feedback. This change has been made on Page 31: Another study found that when the foot was not flat, the ground reaction forces (GRFs) cannot be transmitted effectively through the bones from the ground without the actions of muscles (Anderson and Pandy 2003).
31	.Page 31: "the trunk and pelvis position will have coupled effects	This change has been made on Page 31 and 32:

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	on knee angles" .The knee angle may have effect on the pelvis and trunk …	Because the upper body contains over half of the total body mass, the trunk and pelvis position may likely have an effect on knee kinetics and resultant risk of ACL injury.
32	.Page 32: "The position of the leg at the time of non-contact ACL injury displays tibial rotation, apparent knee valgus, foot pronation, and a relatively extended knee and hip .You did not "display" this information in the paper. What situation is being described here? More detail is needed.	The argument being made in this section of the paper is that in order to study non-contact ACL mechanics one needs to include the ankle and hip articulations (please see title on paper 31 that states: **Lack of studies that include ankle and hip articulation**. This statement "The position of the leg at the time of non-contact ACL injury displays tibial rotation, apparent knee valgus, foot pronation, and a relatively extended knee and hip" is taken from findings by many researchers and written in this context to support the argument that ankle and hip inclusion in non-contact ACL injury research is indeed important. There is no specific situation being described as these kinematics can encompass varied injury mechanisms. Given this, we think that no change is required.
33	.Page 34: "These are termed contact methods and have the advantage of simultaneously including many risk factors," .How does an implanted transducer include risk factors? .All relevant muscles are typically not instrumented	You have taken the sentence out of context, and it seems that what was written was misinterpreted. The sentence read on its own will raise questions as you have here. For further clarity: .In-vivo testing using implantable transducers on human subjects, termed contact methods, has the ability to simultaneously include many risk factors given the human (which is difficult to simulate) is included in the study design while one accesses *in-vivo* data on tissues(s) of interest. By including the human in the study design one innately include muscle activation, joint forces, and applied forces. . Muscles do not need to be instrumented.

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	Which forces?	. Joint contact or externally applied forces. To date we do not know how to mathematically model knee joint contact forces with accuracy. Given this, we think that no change is required.
34	.Page 36: "The major advantage of in vitro testing is its utilization of biological tissue for testing" .In vitro can be defined as "In an artificial environment outside the living organism", so testing biological tissue need not be involved. .Testing in-vitro is a disadvantage over in-vivo, but necessary	. In vitro can be defined as "In an artificial environment outside the living organism", so testing biological tissue need not be involved. This is true as defined in the first sentence of this thesis section " . As per thesis "*In vitro* testing is conducted outside of the body typically with human subjects or post mortem human subjects (PMHS)/ cadavers. So, yes as per statement above we agree biological tissues need not be involved. . Point taken. Given this no change is required.
35	.Page 36: "In vitro testing also has the capability to simulate knee kinematics and muscle loads." .You could also use in-vivo data to drive a simulation	. I have added a sentence on Page 34 to incorporate this point for completeness- thanks for your comment.
36	.Page 36: "Other challenges with in vitro studies using cadavers are the inability to simulate realistic muscle activation and the difficulty in obtaining repeatable results" .This is the same thought as the previous sentence. .Repeatability is difficult in any biomechanical data collection with people	We have made the changes on Page 36 for further clarity: . Other challenges with *in vitro* studies using cadavers are the inability to simulate realistic and high muscle forces and the difficulty in obtaining repeatable results. .Agreed but it is even more so a challenge for in vitro studies using cadavers primarily due to the absence of muscles. Hence, without muscles cannot have repeatable kinematics (Blankvoort 1988, Naval MSc. Thesis).

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37	.Page 36: "Despite its shortcomings, in vitro studies have the capability to provide much freedom to investigate function and behavior of the ACL." .What is meant by "freedom" in this case?	.Ethical policies governing testing with humans limit the use of *in vivo* testing on humans. This limitation does not apply to *in vitro* testing.
38	.Page 36: "From this standpoint, it can be argued that gait analysis is the only way available today to determine the kinematics and kinetics during activity to cause non-contact ACL injury." .Kinematics and kinetics of what? Kinematics and kinetics of muscle-bone-ligament are typically poorly defined by gait analysis. .Can whole body kinematics and kinetics (joint angles, net joint moments, etc.) truly show the cause or just a possible body position and external loading scenario for injury? Only if you actually measure an injury?	This sentence has been revised on Page 36 to the following: From this standpoint, it can be argued that *in-vitro* studies is perhaps the only way available today or the best starting point to determine the kinematics and kinetics during activity to cause non-contact ACL injury. .This exact comment was raised and addressed by the student at the thesis proposal stage. It is not clear that what was the outcome of this effort by the student and why this question is being asked again at this stage?- please clarify.
39	.Page 37: "A computational model of the knee joint is a graphical representation of the joint anatomy" .A computational model does not have to be graphically represented to be used (i.e., a computational model is not a graphical	. Nowhere in the quote do the authors speak of "use". However there is some merit in adding the word "mathematical model" to the sentence. Change made on Page 37 to: A computational model of the knee joint is a mathematical model that can graphically represent the joint anatomy and motion.

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	representation, but can be represented graphically) ."A computational model is a mathematical model in computational science that requires extensive computational resources to study the behavior of a complex system by computer simulation"	
40	.Page 38: "The main advantage of musculoskeletal RB modeling is that it enables us to determine the forces in the muscles during activities implicated to cause non-contact ACL injuries" .Change "determine" to "estimate"	. Change has been made on Page 38.
41	.Page 39: "This may exacerbate itself to much uncertainty in theories used for teaching clinical biomechanics" .What do you mean by "This may exacerbate itself to much uncertainty"? Lack of consensus on theories? How does a lack of consensus make things worse when teaching? The instructor would present both schools of thought.	The authors appreciate this respected examiner's viewpoint and see no serious requirement for amendments. Given this no change was made.
42	.Page 40: "reductionist approach by focusing on a single factor or few factors due to small sample size." .Small sample sizes are not the reason for using methods that have a small number of variables.	. The sentence has been reworded on Page 40 to: Finally, the low annual incident rate for ACL injury in the general population of 1 per 3000 people (Malinzak et al. 2001) -and even smaller in the athletic population- has posed challenges for researchers aiming at

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	.If over 250,000 ACL injures are reported each year in the USA, a reasonable sample size for a study can be achieved .The cost of a large study may be the real problem	pinpointing factors contributing to risk of ACL injury since employing a large population of subjects in study design can be costly.
43	.Page 40-41: Various items in this proposed methodology are difficult to achieve: .That "close to injury joint kinematics" were achieved .Accurate "tibial displacement relative to femur" .Accurate "muscle tendon moment arms and lengths as well as muscle forces" for people that deviate from the model .Since the relative tissue/bone values that are modified by the AI could be wrong but create the desired output, having equivalent net joint moments, etc. does not necessarily validate the model … it just shows that equivalent net joint outcomes could be generated.	There is immense work, cost, and resources from a large research group with varied skill sets to undertake this methodology. .Like the work of this thesis, you need to focus on a motion to create a framework for which you intend to study. If single-leg landing is your scope, then experiments of this nature should first be conducted to obtain physiological motions and possible close to injury situations. The experiments conducted in the lab for this thesis are done to assess the effect of heights, distances, and gender on body kinematics and kinetics during single leg landings. This motion can then be applied to drive a model. Once this model can be validate via some order of magnitude exercise, then it can be applied in a virtual environment by perturbing it, or using an optimization tool to help you better study injury. It can be argued that the only way to study injury is via a virtual environment using physiological inputs as a starting point and an optimization tool to search and find the injury situations. . Obtaining accurate tibial displacement relative to femur was never a claim made in this thesis. No change required. . Obtaining accurate muscle tendon moment arms and lengths, as well as muscle forces were never a claim made in this thesis. The authors do believe that in the future MSM tools will enable one to customized muscle moment arms to subjects body, but from a cost benefit accuracy tradeoff point of view the authors feel this can be a useless exercise. The methodology as proposed does not use anatomy as a design variable.
44	.Page 43: ."Nonetheless, this approach allows	.We do understand your concern, but in the biomechanics community

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	for virtual experimentation which has significant implication for cost reduction through reduced equipment needs, number of subjects required for testing, and also time for testing." .Virtual experimentation would reduce costs if a "perfect" model was built that answered all questions. Since this is not the case, costs are still present to verify if modelled outcomes apply well in the real world.	validating whether a computational model outcome applies well to the real world is not a limitation of this thesis, but a limitation of science. Given the empirical tradition of the biomechanics community, one may argue that computational modeling software were perhaps slow to develop compared to that in the engineering community which undertake numerous virtual experimentation as a cost saving initiative. Further, we think a really good question is to find a study in non-contact ACL research that employs an MDO paradigm. The method is new to the field of biomechanics and if applied to the field as it is envisioned by Dr. Lloyd, Thomas Buchanan, Quatman, Marco Viceconti, Herbert Hatze etc. can yield great benefits. Herbert Hatze at the Geoffrey Dyson Memorial Lecture said that it will become obvious that a large class of problems confronting the sports biomechanists can be ultimately identified as belonging to the field of optimization.
	."In addition, one of the central aims of this proposed approach is to provide an enabling tool to better capture the many variables, constraints, unknowns, uncertainty, and variability entailed in the complex problem of predicting injury mechanisms and identifying risk factors of non-contact ACL injury." .How do you capture unknowns and uncertainty? .It is unclear how the tools helps with this sentence .What do you mean by "capture the interaction" ."This approach should also aim to provide information that can	The application of MDO study paradigm is novel to the biomechanics field. MDO is a system science or system modeling approach to solving complex problems. The researchers mentioned above are among few who are critical to the conventional approaches used in the biomechanics field.

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	connect the cause and effect relationships between ACL loading, injury mechanisms, and risk factors of noncontact ACL injury." .What information would you be providing, for example	
45	.Page 44: The first paragraphs is confusing. After rereading this many times, the author initially states that the model should provide various outcome measures but then states that the kinematic information to create this model is not available so this cannot be achieved? ."One approach to resolve this challenge may be to conduct parametric and sensitivity studies" .Studies of what parameters? .An unreasonable number of studies would be required to eliminate what does not produce an injury, with the objective of only leaving conditions that cause an injury. Therefore, this is not a viable approach	. Quite the contrary. The exact kinematics at the time of ACL injury for side-step cutting or single-leg landing is unknown. It is for this reason that one starts with close to injury situations in the laboratory using a computational model. Now assuming you have a validated computational model, how do you begin determining the mechanisms and risk factors for ACL injury? The few attempts to do this result in many difficulties given there are likely too many parameters at play during non-contact ACL injury event. To resolve this, one can do sensitivity studies which have its pitfalls as highlighted in the thesis. . . Sensitivity studies on variables one feels may or may not be a contributor to the risk of non-contact ACL injury. If there is no effect, then remove it from the problem scope. ."An unreasonable number of studies would be required to eliminate what does not produce an injury, with the objective of only leaving conditions that cause an injury. Therefore, this is not a viable approach." You may very well be right, but this is yet to proven. Sensitivity and parametric studies are a common reductionist approach to solve problems.
46	.Page 46: How can AI be used to "define a problem" .It is unclear how data from different people, different,	. This is a good question, thank you. Within the context of this thesis one can set up the objective function such as to enable the computational model to find the variables that causes the stress at the ACL to exceed yield stress within certain set

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	injuries, and different conditions can be fused to generate useful information, using the proposed input data.	variables and constraints. One will also impose physiological constraints. The objective function and constraints to capture the numerous factors involved. . Please highlight where on Page 46 such a claim is made.
47	.The author states an approach but has not provided a sufficient rationale as to how this can be implemented in practice.	. This is good point. We assume that you understand then "why the proposed approach should be implemented." Many research groups investigating non-contact ACL injury recognize that the problem is multifactorial/multidisciplinary. However, many researcher groups never proposed a way to handle such a problem. The authors of the Paper 1 and Paper 2 has endeavored to fill this gap. It is for this reason that both Paper 1 and Paper 2 are appreciable contributions to science, we believe. Further, determining how to implement this approach is beyond the resources and skill sets afforded to this thesis.
48	.Page 46: "A case was not proven that "the narrow focus of some studies and the dearth of standards and specifications in the field of biomechanics appear to have the effect of limiting progress". Past study methods and standards do not limit how a research can make an advance in the ACL field. Methodological and ethical issues are more likely the limitation.	. The goal of a review paper is not to prove anything but to present what is known about the area of research and further synthesize all the unconnected topics into an integrated "state of the science" review. We will be very happy if this respected examiner can provide a specification or standard used globally by all researchers that can find direct application to non-contact ACL injury research. The paper has been published so further discussion of its merits are irrelevant.
49	.Page 47: Creators of ACL injury prevention programmes know how their system works. There is likely not one key element, so looking for such an element may not be warranted. The holistic approaches	. What system are you referring to?- it is not clear to us. We cannot prevent or design training regimes for something we do not understand. As an example, we would be keen on seeing the body of literature that shows agreement, for example on "flexibility" "or perhaps "increasing strengthen" or any of the other variables you have mentioned, as a contributing factor to non-contact ACL injury. The

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	of avoiding vulnerable positions, increasing flexibility, increasing strength, including plyometric exercises in training, and increasing proprioception should be considered.	question then one is compelled to ask is, why is this the case? Some of the answers are in Paper 1 and Paper 11. The proposed study paradigm can capture the factors that this respected examiner has mentioned and many others in a single problem definition. The paper has been published so further discussion of its merits are irrelevant.
50	.Page 58: Revise page numbers in paper reference	This change has been made on Page 58.
51	.Page 70: "compare rigid and deformable contact scenarios"	This change has been made on Page 70.
52	.Page 71: "multivariate function that" ."The Levenberg-Marquardt algorithm can be thought of as a combination of steepest decent and Gauss-Newton methods." ."This method was modified by Fletcher (Fletcher, 1971) to tailor the amount of dampening used at each iteration so as to" ."Powell (Powell, 1978) to solve an over constrained system of equations via least squares optimization" ."The authors used an AI technique, simulated annealing, to determine" ."Monte Carlo simulations were"	This change has been made on Page 71. This change has been made on Page 71. This change has been made on Page 71. This change has been made on Page 71. This change has been made on Page 72. This change has been made on Page 72.
53	.Page 72: "Mclean et al. (Scott et al., 2004)" .Check reference and spelling of McLean. If reference from Scott's paper, put year of the McLean work.	. Spelling of McLean is correct. However the references have been revised to use Scott's last name. Change made throughout the thesis-thanks for your comment.

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54	.Page 75: "determine if the model can be considered valid."	. This change has been made on Page 75.
55	.Page 61: What is "combined loading" ."Non-contact ACL injury is also a whole body phenomenon that is best analyzed by simultaneously addressing multiple risk factors of which neuromuscular control, joint kinematics and geometry, as well as, external forces that may be the most important." .Are the external forces the most important or other items in the sentence? How are you proving which is the most important (include reference, ...)? .Video analyses are not necessarily qualitative. They may measure frequencies of injury situations, etc.	. Thanks for the feedback. The paper has already been published.
56	.Page 69: What is meant by "Intra subject variabilities may stem from technician performing experiments"?	. Variabilities during experiment within a subject can stem from investigator managing the experiment. Hence, the way instructions are communicated to subjects, equipment setup and calibration etc. from one day to the next may be different and lead to variabilities when testing the same subject.
57	Page 70: ."A later study by Blankvoort et al. (Blankevoort and Huiskes, 1996) used the same mathematical model" .Which one, Blankevoort et al.,	. This has been amended for better clarity. The answer is Blackvoort et al.'s 1991 model. Change made on Page 70. "This model was validated in a later study by Blankvoort *et al.* (Blankevoort and Huiskes

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	1991, Wismans et al., 1980? ."for usage in the model" .Which model? ."Blankvoort research group employed an optimization scheme to estimate the initial strains since no experimental data was available" .You said that the previous model was used in the last sentence? .I do not understand "experiments via the variation of the reference strains in the ligament". Are these other experiments on people?	1996) whereby the effects of the initial strain of ligaments were included." . See change made on Page 70. . See the change made on Page 70 that clarifies this. . Blankvoort (1991) advanced the knee model developed by Wismans (1980) by including deformable contact at the tibiofemoral surface and the effect of ligaments wrapping around bones. The earlier model of Blankvoort (1991) showed that modeling the articular cartilage as a deformable body by adjusting the stiffness properties had little effect on model characteristics. Given this, Blankvoort later conducted a study (Blankvoort 1996) where only the initial strain of ligaments were included. Blankvoort used an optimization scheme to estimate the initial strains since no experimental data was available. Optimization was based on minimization of the difference in kinematic between the knee model and that experimentally obtained by variation of the reference strains in the line element. The ligaments were modeled as 1-D elements. Comparison of knee model's passive motion with experiment was done with data from the literature obtained from earlier studies by Blankvoort's research group (1991) using knee specimens.
58	.Page 72: .Monte Carlo methods are algorithms that randomly generate and retain the best solutions before going to the next search iteration." .This does not seem to be the case for Scott et al, 2008: "The Monte Carlo approach adopted within the current study necessarily considered each perturbed input parameter as independent from the next. In other words, for that N-	. As per the thesis that referenced McLean's 2008 paper, Monte Carlo simulations were also performed by the authors to determine the effects of variability in neuromuscular control on peak anterior drawer force, valgus moment, and internal rotation moment. In general, "Monte Carlo methods are algorithms that randomly generate and retain the best solutions before going to the next search iteration." It should be noted please that this is a weakness of Monte Carlo methods in comparison to AI approaches that can simultaneously handle numerous solutions in each iteration. . Perhaps this sentence should be reworded as

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	dimensional space, we necessarily sampled input conditions from all corners of the hypercube. Adopting such an approach meant that some of the combined perturbed conditions would be highly unlikely in vivo, with performance of a successful sidestep being virtually impossible in these instances."	"With regards to application to Biomechanics, Monte Carlo methods are used primarily to evaluate the probability of random outcomes of human movement." Please let us know if this is OK.
	."Monte Carlo method is used primarily in this application to evaluate the probability of random outcomes of human movement." .This does not seem to be the case for Scott et al., 2008	.This sentence is not supported by the reference. This sentence is our own and no reference is required. Thus, no change has been made.
	."Monte Carlo simulation is an attractive tool since it allows researchers to study and predict risk of sustaining an injury before injury occurs." .This sentence is not supported by the reference	. "does not seem" is quite vague. Please clarify for us.
	."However, simulated annealing is simply mentioned by the authors but the way the method is employed to answer the author's research question is not clear .Scott provides both the equation	. This sentence was not used in relation to McLean et al.'s (2008) work.

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	and reference for the simulated annealing approach	. Yes, the way the method is employed is not clear to us even with this equation and reference. To state just the objective function is not enough. If the problem is clear to you, can you please provide us the answer to the following question: What are the constraints or constraint method use in this study?
59	.Page 73: "whether sagittal plane knee loading during sidestep cutting could in isolation injure the ACL" .How is the injury isolated if the person is sidestep cutting and a load is applied?	. This statement is aligned with the objective of the study by Mclean et al. 2004. As per thesis the sentence reads: "McLean *et al.* (McLean et al. 2004) also applied the identical optimization methods to examine whether sagittal plane knee loading during side step cutting could in isolation injure the ACL." In the study by McLean et al. 2004, a model was used to predict the effect of perturbations in neuromuscular control (NMC) on resultant knee movement and loading. The effects of random variations in NMC during the stance phase of sidestep cutting on 3D knee loading was determined. What the author did is as follows: they investigated the effect of ONLY sagittal plane loading mechanism, comprising of quadriceps and hamstring forces, flexion angle, and external anterior-posterior joint loads (values looked at in isolation using the model) on potential to injure the ACL between genders.
60	.Page 74: "The AI technique is employed to orchestrate the fusion of the two quantitative study approaches in the MDO paradigm," .What are the MDO study approaches?	Please see Figure 2 on Page 76 where the MDO approach is presented.

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61	.Page 74; It is unclear how clinical studies, interviews with athletes, video analyses will be used for validation	. As you have correctly pointed out earlier, it is possible that an AI technique can result in poor solutions. To help guide the search and optimization routine the problem must have some constraints. This is a mandatory process in ALL optimization problems. The process of constraining the problem will enable us to determine physiological results. The constraints can be determined from qualitative studies such as those reported in the literature from clinical studies, video analysis, etc. As an example, from video analysis, we know that typically ACL injury occurs during single leg landing when knee is in extended position and upper body away from the knee. Given AI can handle large ranges for any given variable, we can use this information to limit the range of knee flexion and trunk flexions for example in our problem definition.
62	.Page 74: "An AI technique also enables one to capture the wide variability in movement patterns …" .AI can also generate a wide variety of incorrect results	. Please see answer to question # 60 that can help us understand how to prevent this. The following references were added to the text to support your comments: Such a study approach may be a much more robust and comprehensive methodology to better predict non-contact ACL injuries (Lloyd et al. 2008; Quatman et al. 2009). An AI technique is preferred over OR techniques for non-contact ACL injury studies since they do not require a mathematical function, are more robust in dealing with both qualitative and quantitative variables, enables a system-based type of approach to solving complex problems (Carla 2000), and above all, they share an enhanced ability to handle many design variables and constraints over a large multimodal search space (Brown and White 1990; Holsapple et al. 1994).
63	.Page 75: "The external forces, muscle activation, and muscle forces at this specific lower extremity kinematic should …"	. Lower extremity kinematics refers to the 3D kinematics of the ankle, knee and hip.

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	.What do you mean by a "lower extremity kinematic"?	
64	.Page 77: "It was shown that present challenges in non-contact ACL injury studies stem partly from the inability of existing study approaches to simultaneously capture numerous factors and parameters which are at play during ACL injury." .This was proposed, now shown (i.e., shown is usually associated with evidence, such as evidence that more factors and parameters improve clinical practice). Since error may increase with more parameters, we cannot assume that the final outcomes will be better for a particular method. .Based on this paper, the thesis should combine "biomechanical, environmental, anatomical and hormonal variables". The thesis does not include hormonal or environmental factors ."AI technique is better suited to address present challenges" .Better that OR?	. This paper did expose some of the challenges with existing ACL injury study approaches with the aim of first determining the reasons for these challenges, but more importantly how one can go about overcoming these challenge. Given this, the use of the word shown seems appropriate. Since error may increase with more parameters, we cannot assume that the final outcomes will be better for a particular method. .This is not an issue of errors occurring due to many variables or rounding errors in various stages of analysis: What the proposed MDO approach offers is a scientific method to address the challenges in non-contact ACL injury research. What the approach brings to the forefront is the ability to tie together many disjointed disciplines or departments in single environment so that systems approach to problem solving can occur. This can be done via AI which is a scientific contribution. The five existing ACL injury study approach all have their strengths and weaknesses. Part of the authors argument is that science still does not understand how and why ACL injuries occurs given each existing study approach when used on its own can only address part of the problem and negates many aspects in the problem definition. AI can overcome this challenge. We may all agree that only a multifactorial/ multidisciplinary approach that fuses together these study approaches or is able to capture the variables in the 5 existing study approaches may overcome this obstacle. Now how does one go about this?. The answer lies in the use of an optimization approach. The authors have provided reasons why AI is preferred and how it can be used. We have added more details to the paper to show how this can be

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		done. The paper has already been published. . This thesis is an "article style" thesis. Each paper with its own objectives, methods, and results. The second published paper does highlight the domain of the known risk factors and how they are ALL captured in the MDO study paradigm. . Yes better suited than OR. Change made on Page 78.
65	.Page 87: ."the relationship among sagittal plane body kinematics, knee power, knee work and peak GRFs." ."single-leg landings from platform heights of 20, 40, and 60 cm" ."Subjects also performed single-leg landings from a 40 cm height platform placed 30, 50 and 70 cm from the rear edge of a force plate" .Define first instance of VGRF, PGRF	. Change made Page 87. . Change made on Page 87. . Change made on Page 87. . Change made on Page 87.
66	.Page 88: "knee joint, two key factors"	. Change made on Page 88.
67	.Page 90 "that hip external rotation strength had"	. Change made on Page 90.
68	.Page 91: "Motion capture system (Vicon MX, Oxford Metrics, UK) consisting" to A seven camera motion capture system (Vicon MX, Oxford Metrics, UK) was used to collect …"	. Change made on Page 91-92.

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69	.Page 92: "were instructed to stand on a variable height landing platform (20, 40, and 60 cm)" ."All kinematic data and analog data were low-pass filtered using a second-order bidirectional Butterworth filter at 6 Hz and 20 Hz, respectively." .This sentence could be rewritten so that the reader does not have to reread the sentence to understand, due to the use of respectively. For example, "Kinematic data were filtered using a second-order bidirectional Butterworth filter at 6Hz and analog data were filtered at 20 Hz.	. Change made on Page 92. . Change has been made on Page 92.
70	.Page 93: "correlations were also used to" ."finding of this study (Fig. 2) was that the horizontal" .No highlights/shading were show in Fig. 2.	. No change required as two sets of PPMC analysis were conducted. . I appreciate your suggestion. Change made on Page 93.
71	.Page 97: "Our results corroborate these findings showing that by increasing ankle plantar flexion, there"	. Change made on Page 97.
72	.Page 98: perhaps too short to allow the muscles surrounding the ankle and knee to respond."	. Change made on Page 98.

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73	.Page 99: ."Further, at an increasing landing height, hip and trunk flexion may be more appropriate for attenuating GRFs" both eccentric ."knee power and eccentric knee work were positively and significantly correlated to both peak VGRF"	. Change made on Page 99. . Change made on Page 99.
74	.Page 87: "more appropriate for jump landings" .You have shown that hip-trunk or ankle-knee strategies are used by the subjects, but not that these are the most appropriate.	. Our results suggest that at increasing vertical heights, hip-trunk strategy seem to be used by the subjects while for increasing distance, an ankle knee strategy is used. We have revised this statement to your recommendations. Change made on page 88.
75	.Page 90: "Although the above-mentioned studies reported valuable findings, they lack data concerning sagittal plane kinematics and kinetics of the ankle, knee, hip, and trunk at increased height and distance of landing" .Combining the studies covers a range of heights and they do report flexion/extension biomechanics	.The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see Attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage? Further no single-leg landing studies exist that look at increasing vertical height and horizontal distance. Secondly you cannot combine studies due to tremendous heterogeneity between studies as raised in the review of the literature paper we published as well as discussion from each paper's introduction. Please see Attachment A.
76	.Page 91: .Describe the identical shoes (brand, etc.) .Define the "customized marker protocol"	. The shoe used is ASICS running shoes, model BY004, ASICS America Corporation, Irvine, CA). Change made on Page 91 and this detailed added to all papers. . The Vicon Plug-in Gait marker set was customized to include

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		additional markers at the hip and medial aspects of the elbow, knee and ankle, as well as additional foot markers. Different marker locations were also used at the proximal ends of the pelvis and around the head. Change made on Pages 91 and 92. Furthermore, this change has been made on all papers.
77	.Page 93: .If you are referring to the maximum VGRF, use this term instead of peak. A curve can have many peaks but only one maximum. .0.8 s before VGRF is a long time, is this correct? The entire stance phase in walking can be shorter that this time. A quick check of the literature shows 50-70 ms for time from foot strike to maximum VGRF in a jump landing and the entire event is over within 0.5 s. .Using time as the basis for work calculations can create error, as opposed to event-based criteria, since timing between individuals varies	The first comment has merit but it is not valid. For a single-leg jump landing, there is only one clear distinguishable peak. See Figure 1a in Paper 4 for a good example. . Yes, 0.8s is correct for time take prior to maximum VGRF. The reason for this is first that the subject stands on both legs, transfers the weight over to the dominant leg, and then jumps. This is what takes time. "A quick check of the literature shows 50-70 ms for time from foot strike to maximum VGRF in a jump landing and the entire event is over within 0.5 s." Yes, this is perhaps true, but for what type of task? For a vertical drop jump, maybe. So step one, peak VGRF is a clear and unambiguous event to capture. The end point being plus some time or percentage is very reasonable, because once balance has been established you would not expect large VGRF and visual inspection will verify the rationale for terminating the analysis. This leaves only the starting point, and this can be a bit vague. -0.7 second or -% from peak VGRF is a great way to standardize, because it removes issues of take off mechanics and simply states I'm only interested in what happens after this point, but prior to landing. I think this rationale stands up because the metric of interest is VGRF and the variation in the time in the air is essentially not important.

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		"Using time as the basis for work calculations can create error, as opposed to event-based criteria, since timing between individuals varies." Thanks for the comment. Events were created and used for all studies.
78	Page 93: .Did you use 2D sagittal plane kinematics or 3D flexion-extension for the analysis? I is unclear why you would take 3D data and deconstruct this to 2D sagittal plane analysis, especially since the leg typically rotates out of the sagittal plane during landings. .Correlations <0.7 are not high. Do you mean relatively higher that some other analysis? Typically, 0.2 to 0.4 Weak, low correlation (not very significant); 0.4 to 0.7 Moderate correlation; 0.7 to 0.9 Strong, high correlation; 0.9 to 1.0 Very strong ."knee work as determined at the time of peak VGRF" .Work is typically over a range and not at a single value. How was this calculated?	. Joint 3D kinematics were used. No deconstruction was used. Only data from a single plane used given single leg landing is sagittal plane dominant. This is a good point. The errors in camera calibration, as well as, the skin movement artifacts can be higher in magnitude that the amount of joint movement measured in some planes for the task. This is the case for transverse plane movement data such as tibial rotation, where it has been shown in the literature that skin artifacts for this measurement are larger than the measurement itself. . For clarity please note that this contradicts your comment made later in this review, where you speak to abduction moment. . It is unclear to us how you established that correlation < 0.7 is not high. Please provide reference on the "typical values" suggested. The r=0.698 is taught to be high in this case given the low number of subjects used. .This comment is repeated. This was a mistake in wording. Work was determined over a range, but wording has been to change to reflect this. Power is the product of joint moment and joint angular velocity. This yields a curve when integrated yields work done on a joint. Using events one can mark the location of peak VGRF and integrate from start of task and end at time of peak VGRF. This change has been made throughout the thesis.

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	."The means and standard deviations of the sagittal plane body kinematics, knee power, and knee work" .Is this the mean and SD across all subjects? Please specify for text and figure captions. ."There were no significant relationships between peak VGRF and ankle or knee flexion; however, our results indicated significant correlations between both hip and trunk flexion and peak VGRF." .For which tests (vertical or horizontal)?	. Yes, it is the mean and SD for all subjects. Change has been made on page 92-95. . Greater details have been added to the thesis to better clarify your concern. The necessary change has been made on Page 93.
79	.Pages 94, 95: .In methods you indicated 6 different tests, landing from 20, 40, 60 cm and landing from 30, 50, 70 cm; however, the tables on page 94 only provide one set of means. Is this the overall mean for all trials? .Mean and SD for all subjects need to be shown for each test condition .In Figures and tables, state which test conditions are being displayed in the caption. All conditions have VGRF and PGRF values so you need to specify what the reader is seeing. .Without the data for each trial, I cannot tell from the scatter plots	. Yes, it is the overall means and SD for all trials. The sentence has been amended on Page 93. .The tables of all means and SD have been added to you here as well as throughout the thesis. . The change has been made to the tables. No change required on the figures given the type of test should be obvious from *x* axis label. Thank you. Tables have been added to the thesis. There are six data points, one for each subject at each vertical height and distance (see

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	how each person varies between conditions. .Correlation matrix is stated but only one column of data is displayed.	Fig 1 and Fig 2). This paper has a set objective, thus the variation in other variables for each condition across subjects was not presented. . This is a good point. The word matrix is deceiving. Change has been made throughout the thesis.
80	.Page 96: ."Results of this study showed that ankle and knee flexion to be moderately and significantly correlated with peak PGRF" .0.395 is a weak correlation ."Interestingly, no significant correlation between peak PGRF and hip flexion or trunk flexion was found." .The weak correlations are more interesting than the significance, significance only states that the results is likely not by chance. In these cases, the correlations are low but this result may just be by chance. ."It was also observed that both the eccentric knee power and eccentric knee work demonstrated a moderate to high negative correlation with both the peak VGRF (r=0.493, p=0.037 and r=0.63, p=0.005, respectively) and the peak PGRF (r=0.63, p=0.005 and r=0.475, p=0.105, respectively)." .0.63 is moderate, not high	. 0.395 is a weak correlation depending on which guidelines you follow and on what you are measuring. The following guidelines was used: 0.1 to 0.3 weak 0.3 to 0.5 moderate 0.5 to 1 strong . The following guidelines was used: 0.1 to 0.3 weak 0.3 to 0.5 moderate 0.5 to 1 strong Hence the use of the term "high"

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	.You stated negative correlations but the r values are positive .It will be easier for the reader to understand this statement if they can see the results for each condition in a table ."Results of this study (see Fig. 1 and Fig. 2) support the findings of other studies that investigated a completely different event but demonstrated a significant correlation between peak GRF and risk of knee injury" .This study does not make a link between peak GRF and knee injury risk, and figure 1 and 2 only show a trend between greater GRF for higher and longer jumping distances, as previously known. ."Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings." .This statement is not supported. Even though the six subject's used a different strategy for dealing with landing forces, this does not mean than bending the knee cannot be used as a strategy. ."This does not corroborate the	. This is a mistake. The *r* values should be negative. Change has been made throughout. . Repeated comment. This is a duplication of comment made earlier with regards to presenting means and standard deviation for all subjects at each trial. We have provided throughout the thesis the table and figures you requested. . If it is already known that greater vertical heights and greater horizontal distances leads to higher GRFs, then please provide us the reference(s) that show this. Remember we are dealing with a multisegment structure. Further, this is only one aspect of this study. Once the effects of height, distance and gender are established, what is happening in terms of body kinematics, muscle and joint reaction forces, knee energetics as height, distance and gender change was also investigated. Further, what is the effect of these changes on risk of ACL injury? Given the study protocol was presented to you at thesis proposal stage, we are wondering why was this not raised at that stage? .In this study, peak VGRF and peak PGRF are used as risk predictor variables. Given increasing heights leads to increase GRFs, then there is increased risk of non-contact ACL injuries at higher heights. It has been shown in other studies, as can be found in the thesis, that peak ACL loading occurs at the same time as peak VGRFs. This is the link you are looking for, we think. Further, once this link has been determined, what variables one can determine to attenuate or increase this peak VGRFs.

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	study by Stacoff et al. (Stacoff et al., 1988) which showed that the knee joint angle can be used to reduce the magnitude of the impact loads during landing." .This sentence should be reworded since the results indicate that the 6 subjects did not need to increase knee flexion at maximum GRF for the test conditions, but they could have use knee flexion to reduce impact loads if required.	. We are simply reporting our findings for the six subjects tested. We never claimed that " bending the knee cannot be used as a strategy" instead we stated that "Our results showed that at increasing vertical heights, knee flexion was not correlated to peak VGRF and therefore may have little potential for reducing the risk of non-contact ACL injuries during single-leg landings." Incidentally this is supported by the literature.
	."However, our study is in agreement with findings of Faugenbaum et al. (Fagenbaum and Darling, 2003) who showed that factors other than knee flexion must significantly contribute to an increased risk of noncontact ACL injuries." .Since this study is not testing at an ACL injury level, the study results cannot be used to make a statement on increased risk of noncontact ACL injuries.	. If the subjects "could have used knee flexion to reduce impact loads if required" is unkown. We need to report what our data tells us. Our data show they did not, we are simply reporting our finding.
	."Moreover, it may be inferred from our findings that the ankle may not be effective for modulating peak VGRFs at increased height of jump." .I need to see the results across heights to evaluate this statement ."Our study also showed that at increasing vertical height, an increase in hip and trunk flexion	.Thank you for the comment. We believe this should have been discussed during the period of the student's studies.

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	can significantly reduce peak VGRF and subsequently reducing the risk of non-contact ACL injuries" .Your study showed that a negative correlation existed between hip and trunk flexion and jump height. Therefore, hip and trunk flexion angles were smaller at increased heights. This does not support the statement .Secondly, the study did not look at the effect of using more trunk and hip flexion at a higher height to reduce VGRF. You would have had to have subjects perform a series of jumps at the same high height but with progressively more hip or trunk flexion and the see the effect on VGRF. .Lastly, peak VGRF was not significantly reduced at the higher heights (i.e., higher height, greater VGRF)	.The paper was written with a specific objective. The additional info you seek is not required, but can be inferred quite clearly from data in table 2. . ANOVA analysis was first conducted to test the effect of height on GRFs, and then the effect of distance on GRFs. After running this analysis, if there is a significant effect then we move forward. In our case, we found significance and further ventured to investigate the association between GRFs and kinematics, knee power and knee work. The statement you quoted came from the second round of analysis; given first set of analysis revealed height is associated with peak VGRF. Now table 2 shows that hip and trunk flexion are negatively and significantly correlated to peak VGRF. Since we found a negative value for the correlation between hip and trunk flexion and peak VGRF, what this implies is an inverse association (large values of *X* tend to be associated with small values of *Y* and vice versa). . No, not quite as it would defeat the objective of the thesis. We did investigate more variables but the ones presented provided the greatest level of depth for study reporting and comparisons with the literature. The second state of analysis you are questioning was meant to determine whether the body kinematics, knee power or knee work can modulate the peak GRFs. If they can, then these variables do have a potential to reduce the risk of non-contact ACL injury. It is unclear to us as to what you are asking for. The first sentence of the results section states "As reported in Fig. 1, there is a relatively high positive correlation between vertical height of landing and peak VGRF (r=0.628, p=0.005)."

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81	.Page 97: ."Even though there are no single-leg landing studies to draw comparisons" .A large number of studies on single leg landing report joint angles, for many heights. These can be used for comparison. ."these findings are in agreement with the literature that reported that increased hip and trunk flexion may reduce the risk of non-contact ACL injuries" .The results do not support this statement ."Forward trunk lean and increase hip flexion may place the body COM more anterior and could potentially decrease the contraction demand for the knee extensor muscles (i.e. quadriceps muscles), while increasing the contraction demands for the hip extensors (i.e., hamstrings muscles)" .You reported a significant positive correlation for knee moments and powers, so the results do not support this statement about reducing demands at the knee. ."at increased distance of landing, our study found that there is a statistically significant relationship between peak PGRF and ankle and knee flexion,"	. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). In addition, this comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage? At the thesis proposal a similar claim was made. See attachment A. ALL these papers were refuted and deemed irrelevant to the scope of our work at this time. It would have greatly constructive if you provided these references to demonstrate this. . Repeated comment. This comment was already made and addressed above. . Repeated comment. This was a mistake as reported earlier. The correction has been made to the tables. Text stay as it is given and it does state negative correlations between knee power and work and both peak VGRF and peak PGRF.

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	.The correlation between PGRF and angle flexion was not significant ."Our results corroborate these findings showing that by increasing ankle plantiflexion, there will be a reduction in peak PGRFs for landings performed at increased landing distance" .The results do not support this statement. PGRF is greater at longer distances. Since ankle dorsiflexion was defined as positive, the ankle was dorsiflexed at max PGRF. Also see previous statement about study methodology to verify this statement.	. Thanks for the point. Change has been made. . The fundamental challenge in describing joint angles is the desire to have both mathematical consistency between the descriptions of the different joints (e.g. all joint angles described using the same rules), and have anatomical meaning in the resulting signals. In Visual3D joint angles are simply the transformation from one segment coordinate system to another segment coordinate system. So if two segment coordinate systems are aligned perfectly (even though they may be displaced from each other) the resulting joint angle signal is zero. The ankle angle is a good example of the inconsistency between a general method for modeling (e.g. the segment coordinate system z-axis is aligned from the distal to the proximal end of a segment) and the ankle joint angle that would result from this definition. Using this standard definition, the ankle joint angle during standing would be approximately 70 degrees of dorsi-flexion, which is not the value most people want to see. To accommodate this inconsistency Visual 3D recommends that the user create a second virtual foot segment for which the alignment during the standing trial yields the desired joint angle. There are several ways of doing this, but two potential solutions will be described. We never did this. Instead we took the absolute value of the difference in joint angle between that when the subject was standing on the platform and that when the subject landed. .Thank you. The changes have been made on page 98. Table 2 clearly reveals that "by increasing ankle plantar flexion, there will be a reduction in peak

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	."an increase in distance of landing led to a reduction in peak PGRF" .The results showed an increase in maximum PGRF with increasing distance (figure 2). Values are increasing negatively, due to the force plate axis convention.	PGRFs." A table has been added to the thesis clarify this. . Thank you. This is an oversight, you are correct. The correction has been made on page 98 as follows: "an increase in distance of landing led to an increase in peak PGRF." See page 98 with amendments.
82	.Page 98: ."Perhaps the answer can be found in the time to perform such tasks. For increasing landing heights the time to perform the single-leg landing is very short, perhaps to short to allow the muscles surrounding the ankle and knee to respond." .No timing results were presented to support this statement. These results must be included in the paper. How much less time with increasing height? How does this difference relate to motor control times? .Which time are you referring to, from airborne to landing, from ground contact to maximum force?	. We could determine no reason to substantiate "why at increasing vertical heights of landing, the peak VGRF is poorly correlated to ankle and knee flexion and significantly correlated to both hip and trunk flexion?". Barring the results of this study, we **speculate** that "Perhaps the answer can be found in the time to perform such tasks. For increasing landing heights the time to perform the single-leg landing is very short, perhaps too short to allow the muscles surrounding the ankle and knee to respond." Please note that this is the discussion section of the paper. . We are referring to from takeoff to landing. .Valid point of view–thanks for the point raised here. Our point of view is that statement remains given in the discussion we wanted to talk around and

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	.Without evidence, this statement should be removed.	rationalize our findings.
	."Future studies by the authors will endeavor to employ a larger sample size as well as to account for the effect of gender during single-leg landing from varying heights and distances." .This sentence is typically in the conclusions	.Thank you. It might be the case. But is reads and flows well with the limitations section of the discussion section.
	."The landing strategy recommended here and discussions stemming from this study" .A landing strategy was not recommended in the paper .No discussions from this study were reported	. The paper states: "Our results suggest that at increasing vertical heights, hip-trunk strategy seem to be used by the subjects, while for increasing distance, an ankle-knee strategy is used." . Need clarification and more explanation on this comment. Please provide us
	."Further in vivo and in vitro studies using a large and varied subject population, as well as computer simulation studies are needed to solidly validate our findings, and determine whether the landing strategy found actually reduces ACL loading in vivo." .This sentence can be removed since it is not related to the study (i.e., no ACL-injury inducing findings were reported in the study that would need to be validated)	.This exact comment was raised and addressed by the student at the thesis proposal stage. What was the outcome of this effort by the student and why is this question being asked again at this stage?. This sentence is valid. Removal of this sentence would implicate that the risk predictor variables i.e. peak VGRF and peak PGRF would have to be removed. The validity of using these two predictor variables hinges on what is known in the literature, which as you have stated here has not been proven. However, this as we have stated is a limitation of this study and most of studies of this nature. . How does one determine if a "study results are successfully related to prior studies". Given the lack of consensus and agreement in the

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	."This study investigated the relationships between varying vertical height, horizontal distance, and peak GRFs during single-leg landing and further related these findings to risk of non-contact ACL injury" .The study results were not successfully related to ACL injury	literature as this thesis highlights, this study first reinforces earlier studies of similar nature, but more importantly it adds to the literature the aspect of how the body can modulate knee loads from increasing heights and distances, which is absent from the literature. As well, the author has related his findings to risk of non-contact ACL injury (a domain on its own) which in itself is a contribution.
83	.Page 99: ."Further, at increase height of landing, hip and trunk flexion may be more appropriate for attenuating GRFs" .This statement is not supported by the results .More appropriate that what other strategy? ."while at increase distance of landing, ankle and knee flexion may have more potential to attenuate GRFs" .This statement is not supported by the results .More potential that what other strategy? ."Hence, the biomechanical strategies for decelerating the body in the vertical and horizontal directions may be different." .You can make a stronger statement	. Table 2 shows a negative and significant correlation between both hip and trunk flexion and peak VGRFs. This implies a negative association. Therefore, a high hip and trunk flexion results in lower peak VGRFs. Hence, the statement seems correct to us. The claim of GRFs is misleading and the results do not show this. To be exact this should state peak VGRFs as our results reveal. Change has been made on Page 99. . Note one of the claims made by other reviewers is that ankle flexion at p=0.104 is not significant. Given there were oversights in the way ankle flexion was calculated upon reanalysis, it is thought that this data is greatly significant. . More appropriate has been reworded on Page 99 to avoid any confusion. . See statement above as same argument applies. . We have reworded this statement in the discussion and have moved it up to the abstract to strengthen our argument. Change has been made on page 99 and in the abstract of this paper.

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	since, for your subjects, there was a clear difference between vertical and horizontal landing strategies ."In addition, both eccentric knee power and eccentric knee work was positively and significantly correlated to both peak VGRF and peak PGRF" .PGRF knee work was not significantly correlated	. Thank you the change has been made on page 100.
83	Text edits .Page 104: "explain the higher number of injuries among females"	. Change has been made on page 104.
84	.Page 106: "To undertake this, a relationship between three non-contact ACL injury risk predictor variables (maximum VGRF, maximum PGRF, maximum knee abduction moment) and selected single-leg landing biomechanical variables were studied"	. Change has been made on page 107.
85	.Page 107: "The seven camera motion capture system (Vicon MX, Oxford Metrics, UK) collected marker trajectories at a sampling rate of 250 Hz."	.Change has been made on 108.
86	.Page 111: ."F(1,9)=20.91, p<0.01, partial η 2=0.699 with ankle plantar flexion	. Repeat of previous comments.

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	angles." ."More specifically, there was a significant height×distance interaction Greenhouse-Geisser adjusted" ."interaction Greenhouse-Geisser adjusted F(3.31, 29.79) =3.73, p=0.019; partial η 2=0.293 for peak VGRF, F(2.17, 19.54) =4.13, p=0.029; partial η 2=0.315 for knee internal rotational moment, F(2.58, 112 23.22)=3.15, p=0.05, η 2=0.26 for hip flexion, and F(2.98, 26.79)=3.90, p=0.02, η 2=0.30 for trunk flexion." .This sentence is difficult to read. Please revise.	. Height mis-spelt change has been made on Page 112. Change has been made on page 112-113.
87	.Page 104: ."The number of non-contact ACL injuries is higher among females; however, there is no conclusive evidence that this is due to biomechanical differences between genders. One explanation is the lack of studies investigating gender differences in whole body biomechanics during single-leg landings from increasing vertical heights and horizontal distances." .The evidence is strong that males and females have biomechanical differences for the target activity related to landing (many studies,	. Comment repeated. See Attachment A. This was raised and addressed by the student at the thesis proposal stage. Further, please share with us the studies that determined these biomechanical differences explains the gender disparity in ACL injury rate. Please note that as stated clearly throughout this thesis, the focus of our work is just on single-leg landing.

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	some with large samples). The statement should be revised ."reaction force (PGRF) for males (r=-0.85, p=0.004)," .Assuming that the 6 males are the same people as in paper 4, why is the r value different?	. Please recognize that the *r* and *p* values in paper 3 were revised (See page 96) and also take note that paper 3 jump tasks studied are different from paper 4.
88	.Page 105: ."while nearly significant and moderately correlated to peak PGRF for females (r=-0.542, p=0.13)" .0.13 is not nearly significant at the p<0.05 level ."while no significant interaction was observed for distance and gender" .Why would you anticipate an effect for distance and gender? Both gender group performed the same methods and therefore move the same distance. .What are "ankle plantiflexion angle gender effects" ."There are few single-leg landing studies in the literature" .Many single-leg landing studies are in the literature, I made a quick search and found over 16 studies so far in 2011. The review paper by Schmitz, 2007 has 34	. The sentence has been revised on page 106. . This statement was made for completeness to explain all the interactions studied. . Ankle platarflexion was the only variable found to be significantly different between genders. This statement endeavors to capture this point. . Comment repeated many times. See Attachment A. A quick search on the internet is quite different than a thorough review of the content of these papers to determine its similarities or differences to this work. . See Attachment A. Please review the content of these papers prior to making this claim. If you believe there is merit to your claims, then do send us these studies. Further as a member of the thesis committee why you are raising this point now?- we are just wondering why?

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	references just on the topic of gender differences	. Please provide the study that supports this statement.
	."Further, most single-leg landing studies only report data on the knee joint kinematics and kinetics." .A sufficient number of studies report results for other joint, therefore this sentence should be revised	. This statement is based on what findings or studies- it's not clear to us. We are likely to find a study in the biomechanics field that states the exact opposite.
	."Hence, peak PGRF may also predict the risk of sustaining a non-contact ACL injury" .Alternatively, it may be the increased in resultant force that is the issue and not an isolated increased in the PGRF vector. Greater VGRF also causes an increase in eccentric knee extensor moments.	
89	Page 107: .Please make same changes to Procedures as outlined in the Paper 3 comments	. Thank you. The requested changes have been made in the thesis.

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90	. Page 109: . "ACL injury risk predictor variables and various selected dependent variables" . Please list the variables . "current study did not produce the characteristics distinct biomodal GRFscurve commonly reported during double-leg landing (Dufek and Bates, 1990; Zhang et al., 2000)" . The GRF curves were consistent with single leg landing curves form the literature. The sentence should be revised to compare with single leg landing and not double leg landing, since this is a single leg landing study. . This sentence should also be moved to the discussion since a literature comparison is not needed in the results. . "The demands of the current tasks studied resulted in a smoother increase to GRF" . Smoother than what? . "Therefore, the biomechanical comparisons of double leg landing with single leg landing results in the literature may be limited due to the differences exhibited by the two tasks."	They are too many to list. These variables are clearly labeled and listed in table 1. . This statement is important to the paper and will not be revised. It has now become more apparent why many of your previous comments were made. This is indeed a single-leg landing study and the impetus of making this very simple statement and presenting the first two figures of this paper is to clearly highlight that single-leg landing biomechanics is different from double leg landing biomechanics. . Thanks for your comment. Change has been made on page 110 and 115. . Word change to smooth on page 116. . The statement is valid as it explains why one cannot compare results from double-leg landing with single leg landing. It also explains why there is a lack of data to aid comparison with those in the literature. Finally, it helps one understands that this is the first and only study in the literature investigate the effect of increasing vertical height and horizontal distance during single-leg landing with results related to ACL injury.

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	.Comparing single and double leg landing is not the focus of this paper, so these sentences should be removed.	
91	.Page 111: ."Follow up tests with the three non-contact ACL injury risk predictor variables" .No follow-up tests were described in the methods	. We have added details to better address your comment.
		. Please see table 1 that illustrates only ankle plantarflexion was significantly different between genders and the magnitude of this difference is shown in table 2.
	."Females had significantly less ankle plantiflexion angle than males" .What stats were used for this result?	. Wording has been changed to: "while a moderate but not significant negative correlation for females (r=-0.542, p=0.131)"
	."while a moderate but near significant negative correlation for females (r=-0.542, p=0.131)" .0.131 is not near significant at the p<0.05 level	
92	.Page 112: .Table 2 must provide mean and SD for all outcomes discussed in the results and discussion.	. Please provide us with more details. What exactly is being discussed in the results or discussion section for which data is not presented. The flow of this paper follows a systematic approach. This approach is built with table 1 as the focus. First gender effects are discussed with all necessary data. Given only ankle plantarflexion was different between genders males' and females' data were pooled. From here interaction are studied and then main effects.
93	.Pages 113-114: .Table 2: The results for males are	

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	strange since the ankle is more plantarflexed as the height increases but dorsiflexed (or less plantarflexed) at the longer horizontal distances. This typically means that the tibia is behind the ankle when the foot is flat (assuming maximum VGRF does not occur until the heel contacts the ground). Since the knee is approx. 28-32 degrees flexed and trunk is 17-21 deg flexed, this puts the body in a strange position (see below). The dorsiflexed ankle angle for the women seems more understandable.	. Height has no significant impact on ankle plantarflexion angle. See table 1. This is even more reinforced by looking at the data in table 2. We have looked at the data again in visual 3D and the values obtained from males are what we have reported.
	.As in the figure below, cofg would be behind the base of support and without arm motion recovery of balance would be difficult	. This point is repeated. See above comment for details. One standardizes arm location to reduce variability. Variability can be high in human motion and can prevent one from predicting anything significant. Strict experimental controls will likely introduce other limitations and traded one confounding variable for another. Further, this should have been provided to the student at the thesis proposal stage. This comment was repeated many times so far. Qualitatively only females had trouble with balance especially at the higher heights. The issue of location of body COM with respect to base of support is discussed later on in the paper.
	.Since the SD for ankle angles are quite high (1-5x higher than the mean) does outlier data account for	.Thanks for your comment. This is a very good point. When we looked at the scatter plots of each subject over the various landing configuration, no obvious outliers were noticed. See Attachment F that shows the scatter plot for a male and a female subject. What this figure reveals is that there is an almost linear increase of ankle flexion at each height as distance increases. Further, the Z scores provided (See attachment G) of angle flexion angle for all subjects at all levels were calculated. The Z scores are provided in Attachment G. For the case of ankle flexion angle, no

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	these differences? . This should be discussed . Table 3: Why are the correlations for males greater than in paper 3? . Are all trials across all conditions used for these correlations? . Table 5: Are these correlations for all conditions and all subjects? . Data are duplicated in tables 5 and 7	outliers. For the case of knee, hip, trunk flexion, no outliers. . We think that you must be referring to ankle plantarflexion and PPGRF with this question. Please note that this correlation was corrected in Paper 3. Secondly as mentioned above, the tasks performed in Paper 3 and Paper 4 are different. . Yes, all trials across all conditions for each subject were used. In paper 3, not all conditions were tested. Table 5 is for all conditions and all subjects. . For ease of readership, this was done given the systematic approached used by the paper. Given there are 4 variables that are significantly impacted by height x distance interactions, first the means and SDs are presented (see table 4) and then these four variables are correlated to the three possible ACL injury risk predictor variables (see table 5). Table 6 and table 7 follow the identical approach, but presents only the main effects of height and distance. So, given VGRF is impacted by both height x distance interactions and main effect of height, it is presented in both tables. Note that change was made throughout to correct this and to prevent duplication of data in tables.
94	. Page 115: . See ankle angle comments above . "Our results revealed that females exhibited significantly lower ankle plantiflexion" . Females are dorsiflexed (Table 2) . "which offers a possible explanation	. See Attachment A. See comment above. . This is correct. The word plantiflexion was removed. Change made on Page 116. . Agreed but these studies do show that ankle plantiflexion angles have the potential to modulate the GRFs. Please keep in mind that the time

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	to the higher number of non-contact ACL injuries among females," .Since you are analyzing the ankle angle at maximum VGRF, this point does not relate to the mentioned studies, which are considering ankle angle at initial contact ."Hence, a reduction in peak PGRF may be realized by increasing ankle plantiflexion during single-leg landing which subsequently may reduce the risk of non-contact ACL injury" .PGRF did not decrease as distance increased, so this point is not supported. ."Perhaps an increase in plantiflexion permits more time to distribute the impact forces and better enables the musculature to absorb these forces as demonstrated by the following studies" .This study only looked at the maximum VGRF instance in time so this statement is not supported by the study. ."and implies that horizontal distance of landing--often ignored in most studies--is an important variable"	between initial contact and peak VGRF is short. What our finding shows is that ankle plantar flexion is significantly different between genders and that this difference may offer a possible explanation to disparity is ACL injury rate. . Changes have been made throughout page 116 to clear the confusion with ankle plantiflexion versus dorsiflexion. . This comment was repeated. When you say "this study" we assume that you are referring to this thesis. If this is the case, what this statement is aiming to do is to substantiate our findings with that in the literature. . We cannot understand your comment. We never mentioned anything about force components in this sentence. Please clarify. . Horizontal distance is important. Distance should be considered in future single-leg jump landing studies. We are not quite sure what you are saying. . You failed to include the complete sentence in this quote. "Our results also suggest that knee abduction moment can be modulated by increasing trunk flexion

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	.This force component is not ignored, please rephrase .Importance for what? ACL indicator? I would expect that the resultant force is the main item, with this force being larger if the person jumps farther (higher, longer, or longer and higher) ."Our results also suggest that knee abduction moment can be modulated by increasing trunk flexion" .This statement how you arrived at this statement. Please expand on this and support with the project outcomes. ."Given there are no single-leg landing studies to draw comparisons" .Many single leg landing studies exist for comparison. Please use these.	(see Table 5)." So table 5 is how we arrived at this statement. . This comment is repeated several times see responses above. . We will address the ones you have mentioned. H=height D=Distance . The peak VGRF increased with H and D (see table 6). Knee flexion angle decreased with increasing H (see table 6). Hip abduction angle decreases with increased H and D. Therefore, a negative correlation is reported as per analysis done using SPSS. A negative correlation implies an inverse association. What this means is an increase in X leads to decrease in Y and vice versa. Therefore, the statement with regards to knee flexion angle, that is, increase knee flexion angle is associated with reduced peak VGRFs is correct. We check all other variables you have mentioned and this statement is correct. Further, a positive correlation implies small values of X results in small values of Y, and large values of X are associated with large values of Y. So for example the vertical distance between foot center and body COM increases as H increases. As mentioned already, peak VGRF also increases with increase H. Therefore, positive correlation which implies small values of peak VGRFs is associated with small values of vertical distance between foot and body COM. . This comment was repeated several times. H=height

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	. "Perusal of the main effects of height and distance correlated with selected biomechanical variables (see table 7) revealed that increased knee flexion angle, hip abduction angle, knee power, knee work and horizontal distance between foot and the body COM, as well as, an accompanying decrease in vertical distance between foot and the body COM, is associated with reduction in peak VGRF, thereby demonstrating the possibility of these variables to reduce the risk of non-contact ACL injury. .This statement has many problems. .VGRF increased (i.e., not reduced) .Variables increased as VGRF increased, so how can you prove that these variables reduced risk (i.e., variables increased but VGRF still increased) . "Without studies to draw comparisons" .Other single landing studies exists that can be used for comparison . "In addition, our results revealed	D=distance . peak PGRF increases with increasing H and peak PGRF decreases with increased D (see table 6). Since Knee flexion decreases with increase H, this implies a negative correlation. Checking all the other variables used revealed that this statement is correct. . This is your opinion, which we respect, but our data from this study by no means support this. We have formulated our discussion and conclusions on the findings of the paper. Q angles were not within the scope of this study. . We do not know why females injure their ACL more than males. We both however may agree that there is a difference in average varus/valgus between males and females. Therefore, for the same applied external load, for example during landing, will require different muscle actions to maintain internal equilibrium. The authors of the following papers did just that for single-leg landings (Lawrence RK, Clin. Biomech. 23,6,2008; Nagano Y. et al., The Knee, 14, 2007; and Russel KA, et al., J. Athl. Training, 14,2,2006) and for double-leg landing (Decker MJ et al. Clin. Biomech. 18,7, 2003, Kernosek TW, Med.Sci. Sports Ex. 37,6, 2006, Chappel JD, Am. J. Sports. Med, 30, 2, 2002). Given the distal femur is inherently adducted one might argue that even with a sagittal plane dominant movement like that studied in this thesis, to counter the large loads knee abduction moment may be required. Hence, some subjects may possess larger frontal plane deviations that may likely be countered

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	that at increased in plantiflexion angle, knee flexion angle, knee power, knee work, and horizontal distance between foot and the body COM, as well as, an accompanying decrease in vertical distance between foot and the body COM is associated with a reduction in peak PGRF.	with the abduction moment. Given this, the merit of reporting and studying this variable even for a sagittal plane dominant motion is interesting. Note as well please that the international Olympic committee current concepts statement (Renstrom P. et al. Br. J. Sports Med., 42,6,2008) shows that "a combination of anterior tibial translation (ATT) and lower extremity valgus are probably important components of the mechanism of injury in athletes."
	. Same issues as with VGRF	. We do agree that some people may have frontal plane deviations.
	. PGRF either increased with greater horizontal distances or was almost unchanged (h60d30, h56d50)	. Firstly, this comment contradicts an early comment made on accuracy with regards to values such as tibial rotation. The body center of mass is calculated in Visual 3d, so it is the foot center. For most if not all calibration done with the Vicon system, the mean residual was 1mm or under 1 mm, so one can argue that the range of 30mm is satisfactory. However, we are eager to know how you established that 3cm is within the error of identifying body COM.
	. "knee abduction moment and the biomechanical variables tested suggesting that knee abduction moment may be less a predictor of risk of non-contact ACL injury compared to peak VGRF and peak PGRF for single-leg landing tasks."	It is our view that the body position with respect to the BOS may give some global body (whole body) indication of risk of ACL injury given this value to date assesses balance. Given we know that an object with a lower COM is more stable, we were keen to determine how subjects used this to attenuate GRFs and stabilize their body.
	. This may be due to the female subject sample for the study. Did the subjects have moderate-large q-angles?	As well, for dynamics stability the position of body COM in relation to the BOS influences the body's stability. Given the large mechanical moment arm from body center of mass in relation to the BOS and the body's small BOS when the entire body mass has to be balanced on single leg during landing, the body's COM movement may significantly influence the loads seen at the joint especially more so when the COM is posterior to the BOS. As an example, upon landing, the literature suggests that to modulate the GRF a forward trunk lean may be useful (Blackburn and Padua Clin Biomech, 2008, Olsén et al AJSM 2004).
	. If the subjects did not land in an abnormal knee abducted position, then you cannot test to see if knee abduction moment is a good indicator since the moments would be larger if the person lands with more knee abduction.	. All subjects start the jump task from a standard position on two legs,

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	.Your subjects may have been sagittal plane dominant but some people have larger frontal plane deviations (see literature on females landing)	move to dominant leg and then jump. Given the point of interest at which vertical distance was determine was also standardize we used this to establish globally what the entire body was doing. We wanted to see how vertically collapsed/crushed subjects were and how much this attenuated the GRFs. Interestingly, as a strong positive correlation was determined and further showed from a whole body perspective lowering the body COM can reduce the VGRFs. To date this is a value seldom reported in the literature, but perhaps one to foster more debate in the future.
	."Our findings (see table 7) reveal a significant and high positive correlation between both peak VGRF and peak PGRF, and the vertical distance between the foot and body COM supporting the findings in the literature ...".	. This comment was repeated several times, please see our responses above.
	.The COM results are for vertical COM distance should be discounted since this distance only changed by 3 cm (96-99 cm) and this difference is within the error of identifying COM. Therefore, the data shows that vertical COM could have no real-world effect, even through there was a correlation.	. Please read the entire sentence. The authors accept that the small sample size is a limitation of this study. Given from initial tests conducted in the lab it appeared that trials were similar and given this, it was also decided that a small sample size was ok. . Thank you. The sentence has been reworded to remove the phase landing strategy recommended. Please see Page 118
	.Also, you did not measure the range of COM motion so the study cannot show if COM was lowered.	. This has been amended on Page 119.
	."Due to the lack of studies	

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	examining body kinematics and kinetics over increasing heights and distances, we are unable to fully compare our results with the literature." .If you make a table with the results from the literature, you will have information for many variables over a range of heights and distances, for many subjects. ."relatively small sample size (N=11)," .Comparison size is even smaller (n=5 for females) ."The landing strategy recommended and discussions stemming from this study" .See paper 3 ."Lower plantiflexion angles was observed for females" .Females were dorsiflexed, which will allow the ankle to progress forward to attenuate forces. The problem would be if they landed with 0 degrees and no movement occurred.	
95	.Page 122: "While contributing to an understanding"	. Change made on page 123.
96	.Page 128: ."uses the anthropometric data measured for each subject to scale	.We think that no change is required.

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	the MSM (Rasmussen, 2005). An optimization-based method …" . "taken, firstly, we compared" . "This information is presented in an on-off timing curve (Fig. 2) that shows when the measured and predicted muscles activity goes above (turns on) and below (turns off) a 20% threshold during single-leg landing. Secondly, …"	. Change has been made on page 128. . Change has been made on page 128.
97	. Page 129: "using the subject-specific MSM, example provided in Fig. 3, after completing"	. Change has been made on page 130.
98	. Page 131: "Separate 3×3 two-within-one-between subject repeated measures ANOVAs were conducted"	. Change has been made on page 132.
99	. Page 122: . "Results revealed no significant gender differences in the musculoskeletal variables tested except peak VGRF (p=0.039), as well as, knee and hip axial compressive force (p=0.05, and p=0.032, respectively)." . In paper 4 no significant difference was found for VGRF but the 3 subjects that were selected for paper 5 show a significant difference. Therefore, the selection of these 6 subjects is questionable.	. The 6 subjects used for this paper are a subset of the subjects used in paper 4, but there were height and weight match as far as possible. We re-did the stats to test the effect of gender on VGRFs and the results reported in paper 5 are correct (See attachment B). We also re-did the stats on paper 4 to make the same inquiry and the results reported for paper 4 are also correct (see Attachment C) The only small issue we can see is as follows: 1. The filter used to smooth the analog signal for visual 3D and AnyBody were a bit different. But, given all the data went through the identical filter process, we know this should have no effect on the test for variances. Regardless, the rationalizing why this is the case fails us at this time. . Nothing special was done to select subject from the population except

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	.Since axial load is related to VGRF, these significant differences could also be attributed to subject selection from your population sample.	that they be height and weight match as closely as possible. We would really like to know how you have determined that "axial load is related to VGRF". How is it related? Please share with us the mathematical relationship that captures this relation? We are eager to know and learn from you.
100	."Our results showed no significant association between quadriceps force and risk of ACL injury" .This makes sense since you did not have injury inducing loads during testing ."Within the limitations of the subject-specific MSMs, our findings indicate that musculoskeletal variables studied are not the sole determinants to ACL injury." .It is difficult to make a statement on ACL injury based on the methodology	. This comment was repeated many times. Please see above for response. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). What are the loads to induce injury to the ACL during implicated injury mechanisms? This data does not exist in the scientific community. We do have *in-vitro* data and using this data we can all agree that the experimental protocol used here exceeded the load to failure limits of the ACL. Now the question is why did the ACL did not fail? The answer perhaps lies in the body kinematics as well as the active response of muscles to attenuate these loads during landing. . Why is it difficult? Please let us know what methodology or approach would you suggest to study risk of ACL injury during sport movements? If your statement had any validity, it would invalidate the thousands of experimental *in-vitro* and computational modeling studies in the scholarly literature in the domain of non-contact ACL injury.
101	.Page 124: .Check references for Shin (2007,2009, 2011), Mokhjtarzadeh, Yeow, et al. (2010), Bulluck (2010 - Masters Thesis) for models and single leg landing .Since loads at 60 cm are non-injury inducing but higher than the	. Thank you for the references. Shin's research group work is based on a finite element model, which is quite different from a musculoskeletal model (see paper 1 for differences). . Mokhjtarzadeh, Yeow, et al. (2010) work was published in a conference proceeding. . Work of Yeow' research group was referenced in the thesis and used for comparisons. Note that the scope and test protocol for Yeow's research group work

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	lower heights, are the lower height trials necessary if the focus is on ACL injury? .Bulluck performed a similar study so his results should be used in the comparison. Especially since quadriceps and hamstring results were different. ."The ability of body kinematics or lower extremity muscles to attenuate the GRFs upon landing from a single-leg requires further investigation." .This broad statement is not supported. Many studies exist in the literature, what aspect of force attenuation is lacking? .What do you mean by "elaborate internal joint loads"?	is not the same as ours, e.g. barefoot landing. .Could not find anything on Bullock. The identical comment was raised at the thesis proposal in which several papers were presented as being identical (see attachment A). How did you establish that the loads at 20 cm or 60 cm are non-injury inducing. Kindly provide us the study(s) that shows this. We are eager to learn. The three heights were used to provide three data points that would enable one to study trends. Two data points will always result in a linear relationship. . We would be glad to look into this reference to assess its merit for inclusion in this work. . Comment repeated several times. Please see our responses above. See attachment A. Change has been made on page 125
102	.Page 125: .Weight and height matching of the males and female populations does not necessarily improve the methods since females are typically shorter and lighter than males. .What shoes were worn (brand, etc.)	. Weight and height matching was not done to improve the method. It was used to reduce the variability in results caused by BMI. BMI has been implicated as a contributor to risk of ACL injury. . Thank you. Change has been made on Page 126.
103	.Page 128:	. Change has been made on Page 124

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
	.Define AMS .IDA is not used later in the text so this abbreviation can be removed ."Secondly, the joint forces and moments measured in vivo at the knee joint during gait and reported in the literature were compared with predicted knee joint forces and moments" .Include reference to this gait literature. Was this walking gait? Both males and females? .This paragraph can be rewritten to more clearly show the methods. For example, ."Secondly, the joint forces and moments measured in vivo at the knee joint during gait and reported in the literature were compared with predicted knee joint forces and moments (Table 1). The MSMs were driven with the individual subject's knee joint forces and moments obtained from single leg drop landing trials. "Based on these findings and recognizing variability in body anthropometry between studies, it appears that the developed subject-specific MSMs tends to .reproduce the trends in internal	. The resubmitted manuscript uses this acronym more than once so no change required. . Change has been made on Page 129. .Yes, walking gait. .Yes, both males and females . Thank you for the suggestion offered. We feel the text reads well given the MSMs are not driven with the individual subject's knee joint forces and moments obtained from single leg drop landing trials.

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
	forces and moments well while systematically overestimating the joint reaction forces." .Which findings? The literature review? .No trend for most measures in table 1 (i.e., only one comparison value) .Anybody results are higher than the range for Fz and Fx only, therefore they do not reproduce the trends and did not show a systematic overestimation (Fy was not higher) .What are the Anybody results? Mean of all 6 subjects? ."The latter can be controlled in the MSMs by adjustment of muscle moment arms, but in the interest of reproducibility it was elected to not pursue this option." ▪What is "the latter"? ▪ So what was done to correct the models? Was the error left in place?	. We are referring to the outputs from the MSMs . Change has been made on Page 130. . Change has been made on Page 130 . The moments at the joints are primarily what are used to balance internal loads with externally applied loads. These moments as shown in table 1 are well within the *in vivo* data from the literature. The joint reaction force, Fy, is very nicely within the magnitude of *in vivo* data from the literature. . Anybody results are provide in table 1 second column labeled "predicted by AnyBody MSM". The data for the MSM is for a single subject. This subject was our heaviest subject given the body weight of subjects available in the literature. . The latter refers to the overestimation in joint reaction forces. . What correction you feel is warranted. Further, what error you speak of. A model is a representation of reality and in no means a way to directly compare with the human body. It is simply an order of magnitude comparison.
104	.Page 128: ."The time at which peak VGRF occurred was used to determine the selected musculoskeletal variables."	. This sentence is correct.

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
	.This sentence indicates that the VGRF time in seconds was used to select the variables used in the analysis. Since this is probably not the case, please revise.	
105	Page 130: Figure 2: .The activity and start-end events are unclear. .Including event timing in the figure would help the reader (foot strike, etc.).	. We do not see the value in adding events at a threshold of 20%. At this threshold only initial contact may be worth reporting.
106	.Page 132: ."Nonetheless, the trends in the predicted muscle activations (thin lines) sets in reasonably close in time as the measured muscle activations (fat lines), therefore demonstrating fairly good agreement between model prediction and experimental data" .What do you mean be trends? .The comments of "reasonably close" and fairly good" do not support the use of the defined model for further study. Tibialis anterior and rectus femoris are quite different and the timing/duration factors could adversely affect the model's ability to predict forces.	. By trends we mean the period of time and length of time the predicted muscle activity is over the 20% threshold. . Naturally this would be the case for any computational model given the state of science to date. Aiming for anything that is more than an order of magnitude comparison is not realistic. Please let us know how would "the time/duration factors adversely affect the model's ability to predict forces?" and How does one address this in the muscle model?

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
	.It is not clear where Figure 3 shows the interaction with the environment	. Thank you. This has been corrected on Page 133.
107	.Page 133: .Figure 3: It is questionable to state that the model has been validated due to the errors.	. Model validation is a great discourse in the field of biomechanics and is a place where anyone can easily attack. Please consult the on-off timing curves provided on for model validation. For the most part, this is the gold standard for MSM validation if validation is done in the study. We have done this and to further acquire confidence in our model we compared our model predictions to *in-vivo* data from the literature. Model validation requires experimental data to facilitate validation. In many cases, like ours, such data is difficult to obtain, or may never be obtained. The validation in this thesis is to show the model outputs reasonable trends for joint reaction and muscle activation. In general, ALL musculoskeletal models overestimates the internal forces. It seems that everyone in the musculoskeletal modeling community will agree that ALL MSMs yields larger joint forces than they would expect. We will be keen to understand what threshold of error warrants a MSM model valid in the field of biomechanics. Further, please be aware that for the *in-vivo* studies all subjects were heavier (i.e. ~335 N heavier than the heaviest subject in our study). To date, no data exist for subjects within our body weight.
	.A table of means and SD for main measures is required (maximum VGRF, Hip & Knee axial forces, max PGRF, max Proximal tibial shear force, etc.), with male and female results separated.	. The table of the dependent variables that are significantly different between genders have been added on page 135.
	.Later in the document, Table 3 provided some data, but only for the entire sample. The male and female results are needed separately since this is the analysis that is presented.	. See comment above please.

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
	."Between genders, females had significantly lower peak VGRF, as well as, knee and hip axial compressive forces." .What statistic was used for this post hoc analysis?	. Multiple 3 way mixed design with repeated measures ANOVA was used.
108	.Page 134: .Figure 4 .Revised to only show the data from foot strike onwards (inactivity from 8-85% is not needed for these graphs). .Y-axis scaling should be the same for males and females .In a printed version, I cannot distinguish the curves by the legend. PDF enlargement to 300% was sufficient.	. Revisions has been made on pages 135 and 136. See Attachment D and E. . Revisions has been made on pages 135 and 136 See Attachment D and E. . The figures are presented to show the trend in the data.
109	.Page 135: ."From descriptive statistics -not presented- one can observe an almost linear increase" .Since these statistics were not presented, I cannot observe this increase. ."Follow up test with this variable and the two non-contact ACL injury risk predictor variables revealed no significant correlation." .What was this followup-test. Please provide the methods and	. Please take a closer look at Figure 5a. . Change made on page 132.

No	Examiner's D Comments and location in Original PhD thesis	Authors' Comment
	results or remove from the paper. .Is height the jump height or the subject's height? ."Results revealed no significant height×gender, height×distance or height×distance×gender interactions (Table 1). .Table number is incorrect in paragraph	. We assume that you are referring to Table 2. In this table, we are referring to jump height. .Change has been made.
110	.Page 137 .Figure 5: The y-axis label is muscle force; however, the EMG data was not scaled to force but to a % of maximum voltage. How did these data become converted to BW?	. Figure 5 are outputs from the MSMs.
111	.Page 138: ."This study showed that single-leg landings did not produce the characteristic bimodal VGRF curve commonly reported for double-leg landings" .Yeow (2010) had similar shaped curves in his study that tested both single and double leg landing. .The reason could be that you did not allow arm movement on landing. Therefore you are correct that the difference was related to the task but it should be mentioned that you are dealing with a "single leg	. Thanks for your points. What you have highlighted simply reinforces our findings. Yeow's (2010) work was referenced throughout this thesis. . This comment is repeated many times. Please see responses above.

CO-SUPERVISORS' LETTER OF SUPPORT

Sonia Letourneau

From: Christine Bourbonnais-Hendley
Sent: 15 mars 2013 21:38
To: DEANGRAD
Subject: FW: Request Letter to the Dean (Mr. Nicholas Ali, PhD candidate).
Attachments: Request letter to the Dean, Dr. Hastings (from Nicholas Ali's co-advisor).pdf

Pour vous.

Christine B. Hendley
Gestionnaire des services aux étudiants et aux facultés (2e et 3e cycles) Manager of Services to Graduate Students and Faculties Faculté des études supérieures et postdoctorales / Faculty of Graduate and Postdoctoral Studies Université d'Ottawa / University of Ottawa Pavillon Hagen Hall pièce 107 / Room 107
115 Séraphin-Marion
Ottawa On K1N 6N5
tel: 613-562-5800 x 1228
fax: 613-562-5992
cbourbon@uottawa.ca

-----Original Message-----
From: Gholamreza Rouhi [mailto:grouhi@uottawa.ca]
Sent: Friday, March 15, 2013 3:49 AM
To: Christine Bourbonnais-Hendley
Subject: Request Letter to the Dean (Mr. Nicholas Ali, PhD candidate).

Dear Ms. Hendley,
This email is from Mr. Nicholas Ali's PhD thesis co-advisor. The attached letter is a request to the Dean, Dr. Hastings, in regard to Mr. Nicholas Ali's PhD thesis defense.

Would you please confirm if you've received my email?.
Best regards,
GR

--
Gholamreza Rouhi, PhD
Assistant Professor, Faculty of Biomedical Engineering, Amirkabir University of Technology, Tehran, Iran
http://bme2.aut.ac.ir/odbl/

Adjunct Professor, Faculty of Health Sciences, School of Human Kinetics,University of Ottawa, ON, Canada

March 14, 2013

Dear Dr. Hastings,

This letter is in regard to Mr. Nicholas Ali's PhD thesis, and the decision made on his dissertation by the Faculty of Graduate and Post-Doctoral Studies. I was Nicholas's PhD co-advisor from the 1st day of his doctoral studies at the University of Ottawa. Unfortunately, I left University of Ottawa almost one year ago because of my wife's situation. I'm always eager to serve Canada, a great land, where I surely owe to, as well as to support my previous school, University of Ottawa, in any capacity I can- this is my heartfelt. Needless to mention that I, so far, spent numerous hours of my time to support Mr. Ali, and do expect to see an acceptable outcome at the end of his PhD. I am happy of devoting considerable amount of my time to supervise this student, because of the outcomes I see from his thesis. I am very sure that what he has done during his PhD at the University of Ottawa is enough to grant him a PhD degree, but am not sure if he could present his work in a solid and convincible way.

After hearing that two examiners are still negative about Nicholas's work and he cannot defend his thesis, my first impression, honestly speaking, was that this is not a scientific motion, but just politics. But, after carefully reviewing the respected examiners' questions, comments, and criticisms on Nicholas's revised thesis, my negative impression was changed, and the following points came to my mind, which I'd like to share with you, and am very positive to get your support that can give benefit to my previous school (University of Ottawa), the hopeless and depressed student, the advisors, and also the science: (a) The negative impression of the examiners was mainly caused by the way the thesis was written down, i.e. as a collection of published/accepted/submitted papers, which did not have in many cases a smooth flow, and can easily mislead the readers/reviewers. Moreover, another key factor for the harsh review of one of the internal examiners was the immature behavior of the student, which I hope can be addressed now; (b) Another main factor for encouraging the examiners to be as critical, and possibly harsh, as possible, was including two review articles, in which some idealistic approaches have been proposed to tackle the problem of *non-contact ACL injury during single-leg landing activity*, but not included/applied in the proposed methodology in the real sense in the thesis; (c) The most critical reviewer was Dr. Lemaire with mostly very appreciable and constructive comments (and very few number of harsh comments, and tough expectations), which the former comments can

improve Nicholas's work, as well as the way the thesis was written down. The student was advised to carefully apply all constructive comments of this respected reviewer, and provide point-by-point answer to his other (tough expectations) comments/questions. We, those who are working in multidisciplinary fields, such as biomechanics, all know that nobody's work is flawless, so we should not expect a PhD student to do a flawless work, or a work which contains and include all points that I, as a reviewer or examiner like and am aware of, or am concerned about; (d) Regarding Dr. Caldwell's comments, most of them can be easily addressed. His comments are also very constructive and he believes that it is almost impossible to fully understand the results of the experiments, and the value of the conclusions. We highly respect his concern, and the student is fully ready to address his concerns in regard to the validity of our results. One main reason to mislead this respected examiner was the way the thesis was written, as well as inclusion of the review papers with idealistic and critical thoughts, which were not applied in practice in Mr. Ali's thesis; and (e) Dr. Pierrynowski's comments are also constructive and quite addressable, but his concern is that his comments cannot be fully addressed in a short period of time, which we do agree.

After more than five years working with Nicholas, I can say that this student is a very independent, hard working, ambitious, and sharp student. He has a very solid background in basic Mechanical Engineering courses, and due to his presence at the School of Human Kinetics, he has now a very good understanding of Knee Biomechanics, Biomechanics of Musculoskeletal Systems, as well as Human Kinetics. Nicholas is now familiar with many experimental methods, which are employed in studying human movement. Moreover, because of his presence in a well-known school of Biomechanics in Denmark, in order to do one phase of his PhD, he is now familiar with a powerful tool to analyze various human motion disorders. In regard to Mr. Ali's personality and maturity, honestly speaking, when I compare his behavior when he started his PhD at the School of Human Kinetics with his current attitude and behavior, he is much mature in both his behavior and interactions and communications with others, and also in the way of thinking and tackling scientific problems.

I do believe that Mr. Nicholas Ali's work deserves more appreciation, as it is based on an important and well-defined problem with a solid methodology and approach; but his thesis should be fully reshaped, as it is, in its current shape, misleading. I cannot even imagine leaving

this student without a PhD degree, considering his exemplary effort during last 5 years, as well as his great contributions to the field of biomechanics. Thus, I'd humbly like to request you, respected Dean of FGPS, please to give Mr. Ali a couple more months, I think if you kindly agree to give him 4 more months, i.e. till Sep. 2013, to fully address all the reviewers' comments, and to re-write his thesis with a smooth flow and in a more precise and convincible way. I will strongly support Mr. Nicholas Ali, as I did so far (even after leaving University of Ottawa, in spite of my abnormally tough life in Iran), in order to finish his job strongly and successfully. I again greatly appreciate all the examiners' comments, and promise to continue my strong support to this student who is in a very tough and abnormal situation. I also very much appreciate your kind attention to my request in advance.

Sincerely,

Gholamreza Rouhi, PhD

Assistant Professor, Faculty of Biomedical Engineering, Amirkabir University of Technology, Tehran, Iran, http://bme2.aut.ac.ir/odbl/

Adjunct Assistant Professor, Faculty of Health Sciences, School of Human Kinetics, University of Ottawa, ON, Canada

uOttawa

Université d'Ottawa
Faculté des sciences de la santé
École des sciences de l'activité physique

University of Ottawa
Faculty of Health Sciences
School of Human Kinetics

14 February 2013

Appeals Committee
Faculty of Graduate and Postdoctoral Studies
University of Ottawa

Dear Committee members

I am writing in support of **Mr. Nicholas Ali's** appeal regarding his thesis committee's decision that his article-format thesis is not ready for an oral defence. The decision not to allow a defence has then resulted in a failure to complete his PhD. This is an unfair result considering the years he has committed to the degree and the success he has had in publishing five peer-reviewed publications. In particular, three of the publications are due to scientific research and have advanced the state of knowledge concerning the topic of his thesis research. I would also add that he was by far the principal author of all the papers and the thesis documents. His supervisors (myself and Dr. Rouhi) were mostly editors of his papers and advisors to the procedures taken to quantify and analyze the data. Mr. Nicholas is completely responsible for the contents of the papers. You will notice two additional authors on one paper. These were professors at another university that helped him with the development of his single-leg landing model. Such a model did not exist before Mr. Ali's thesis was completed. This testifies to his contribution to knowledge—a requirement of a PhD candidate. In other words, he has fulfilled all the requirements of a doctoral candidate as outlined on the FGPS's website:

> A doctoral thesis must constitute a significant contribution to knowledge, embody the results of original investigation and analysis on the part of the student and be of such quality as to merit publication.

I do not believe that the concerns expressed by the thesis examiners should have resulted in an outright failure. I have spoken with Mr. Ali about a number of the concerns and feel he could defend his thesis papers successfully.

Sincerely,

D. Gordon E. Robertson, PhD
Emeritus Professor
Fellow of the Canadian Society for Biomechanics

613-562-5852
613-562-5149

125 Université / University
Ottawa ON K1N 6N5 Canada

www.uOttawa.ca

ASSORTED CORRESPONDANCE

Sarah Charette

From: Margaret Moriarty
Sent: February 8, 2013 11:08 AM
To: Sarah Charette
Subject: RE: Procedure of appeal

Dear Mr. Ali,

You can appeal to the Executive Committee of the FGPS, indicating the basis for your appeal. You do so by writing to the attention of the Executive Committee of the FGPS, within 10 working days following the date at which you were notified of the decision being contested. When you send your letter of appeal, you should provide any document that supports your appeal/argumentation.

The following link will lead you to the FGPS Regulations and Procedures regarding theses and research papers: http://www.grad.uottawa.ca/Default.aspx?tabid=3572.

Sincerely,

Sarah

Sarah C. Charette
Secrétaire/Secretary
Faculté des Études Supérieures et Postdoctorales/Faculty of Graduate and Postdoctoral Studies
scharet2@uottawa.ca
Tél.: 613-562-5800 ext. 1223
115 rue Séraphin-Marion
Ottawa, Ontario K1N 6N5

-----Original Message-----
From: Sonia Letourneau
Sent: February 7, 2013 1:51 PM
To: 'nali065@uottawa.ca'
Cc: DEANGRAD; Sarah Charette
Subject: RE: Procedure of appeal

Good afternoon,

Sarah Charette will respond to your email shortly.

Cordially,

Sonia Létourneau
Tél. / Tel: 613-562-5800, poste / ext. 1234 Télec. / Fax: 613-562-5730 sletourn@uottawa.ca

-----Original Message-----
From: nali065@uottawa.ca [mailto:nali065@uottawa.ca]
Sent: 7 février 2013 13:40
To: Sonia Letourneau
Cc: 'nali065@uottawa.ca'; DEANGRAD; Sarah Charette
Subject: Re: Procedure of appeal

Sonia:

Thank you for your response. Unfortunately it does not answer my questions addressed to the Dean. The policy on appeals for thesis evaluations states that appeals must be based on the grounds that "appropriate procedures"
were not followed. I assume this means appropriate procedures for the evaluation of theses. Can you please provide me with any policy, regulation or procedure regarding the evaluation of theses? I understand that my appeal must be limited to any issue arising from a potential breach of those procedures. I look forward to hearing from you.

Kind regards,

Nicholas

Dear Dr. Hastings:

Re. your letter dated January 30th 2013, you referred me to paragraph 10 in the Appeal procedures. Paragraph 10 of the Appeal Procedure states:

"Comprehensive examinations, thesis evaluations and thesis defences, being conducted by a panel of examiners in accordance with established procedures, are not subject to the appeal provisions of this regulation.
Their decisions may, however, be appealed to the Executive Committee of the Faculty of Graduate and Postdoctoral Studies, which, depending on the nature of the complaint, will take appropriate action to ensure that it is clear that justice has been done. If the student is

not satisfied with the outcome of such action, he may appeal to the Senate Appeals Committee on the grounds that appropriate procedures have not been followed."

Questions:
1. Can you please provide the established procedures mentioned in the first sentence of paragraph 10?, and
2. Can you please provide the appropriate procedures mentioned in the last sentence of paragraph 10?

In the event you are not able to address these questions, kindly direct me to the person I can contact to provide the information requested. Dr.
Hastings I am grateful for your help with this matter.

Kind regards,

Nicholas

> Good afternoon Mr. Ali,
>
> Dean Hastings has asked me to send you some information concerning the
> procedure of appeal. Requests of appeal must be submitted within 10
> working days from receipt of the decision (in your case, the deadline
> is Friday, February 15th). The documentation should be sent to the
> office of the Assistant Dean and Secretary General, Dr. Moriarty. The
> request of appeal will then be examined by the Executive Committee of
> the FGPS. If your appeal is not granted, you can submit a request of
> appeal to the Senate Appeals Committee.
>
> For any further information concerning the procedure of appeal, you
> can contact Ms. Sarah Charette
> (scharet2@uottawa.ca<mailto:scharet2@uottawa.ca>, extension 1223) at
> the office of Dr. Moriarty.
>
> Sincerely,
>
> Sonia Létourneau
> Secrétaire du doyen | Secretary to the Dean Faculté des études
> supérieures et postdoctorales | Faculty of Graduate and Postdoctoral
> Studies Pavillon Hagen Hall
> 115 Séraphin-Marion (209)
> Ottawa, ON K1N 6N5
> Tél. / Tel: 613-562-5800, poste / ext. 1234 Télec. / Fax: 613-562-5730
> sletourn@uottawa.ca<mailto:sletourn@uottawa.ca>

> information. Access, copying or re-use of any information contained
> therein by any other person is not authorized. If you are not the
> intended recipient please notify us immediately by returning the message to the originator.
>
>

Sarah Charette #5033260.

From: Margaret Moriarty
Sent: February 11, 2013 1:15 PM
To: nali065@uottawa.ca
Cc: Sarah Charette
Subject: RE: Request for extension to file appeal due to medical circumstances

Dear Mr. Ali,

This is to confirm that the extension is granted for the reason stated. Your appeal will now be on the agenda of the 2 April 2013 meeting of the Committee. You will need to file your appeal documents by 25 March 2013.

Regards,

Margaret Moriarty, Ph.D. (C. Trans. ATIO) Secrétaire générale/Secretary General Faculté des études supérieures et postdoctorales Faculty of Graduate and Postdoctoral Studies
Tél./Tel: (613) 562-5800 poste/ext.: 1221

-----Original Message-----
From: nali065@uottawa.ca [mailto:nali065@uottawa.ca]
Sent: Monday February 11, 2013 11:53 AM
To: Margaret Moriarty
Subject: Request for extension to file appeal due to medical circumstances

Dear Dr. Moriarty:

My name is Nicholas Ali and I am a PhD candidate in School of Human Kinetics. I am planning on filing an appeal to the Executive Committee of the FGPS regarding a decision letter signed by the Dean Dr. Hastings dated January 30th 2013.

Unfortunately I have been suffering from anxiety which has affected my ability to prepare my appeal as fast as I would have hoped. As such, I am requesting an extension until March 15, 2013 to submit my appeal. Please find enclosed a medical note to this effect.

If you could please let me know at your earliest availability if the extension is granted, that would be greatly appreciated.

Sincerely,

Nicholas Ali

Sarah Charette FW to MM · on 12/02/2013 ·

From: nali065@uottawa.ca
Sent: February 12, 2013 1:51 PM
To: Sarah Charette
Cc: Sonia Letourneau; 'nali065@uottawa.ca'; DEANGRAD
Subject: RE: Procedure of appeal

Dear Sarah:

Thank you for the information provided; unfortunately it does not answer my questions.

The appeal I am filling is related to my thesis evaluation and the applicable regulation is regulation 10.3 on Revision of Grades and Appeals (http://web5.uottawa.ca/admingov/regulations.html#r43). The section pertinent to my case states:

"At the graduate level, the jury's decision may, however, be appealed to the Executive Committee of the Faculty of Graduate and Postdoctoral Studies on the grounds that appropriate procedures were not followed.
Students who are not satisfied with the outcome of this process can appeal, on the grounds that appropriate procedures were not followed, to the Senate Appeals Committee."

My questions are:

1. I understand that I can only appeal based on the ground that "appropriate procedures" were not followed. I assume this means the appropriate procedure for thesis and thesis evaluations. If this is correct, please provide any and all applicable "appropriate procedures." I am not looking for the appropriate procedures to file an appeal - I have already been informed that the appeal policy applicable is Regulation 10.3.
2. Can you please provide the appropriate procedures mentioned in the last sentence?

In the event you are not able to address these questions, kindly direct me to the person I can contact to provide the information requested.

Kind regards,

Nicholas

> Dear Mr. Ali,
>
> You can appeal to the Executive Committee of the FGPS, indicating the
> basis for your appeal. You do so by writing to the attention of the
> Executive Committee of the FGPS, within 10 working days following the
> date at which you were notified of the decision being contested. When
> you send your letter of appeal, you should provide any document that
> supports your appeal/argumentation.
>
> The following link will lead you to the FGPS Regulations and
> Procedures regarding theses and research papers:
> http://www.grad.uottawa.ca/Default.aspx?tabid=3572.
>
> Sincerely,

>
> Sarah
>
> Sarah C. Charette
> Secrétaire/Secretary
> Faculté des Études Supérieures et Postdoctorales/Faculty of Graduate
> and Postdoctoral Studies scharet2@uottawa.ca
> Tél.: 613-562-5800 ext. 1223
> 115 rue Séraphin-Marion
> Ottawa, Ontario K1N 6N5
>

>
>
>
>
> -----Original Message-----
> From: Sonia Letourneau
> Sent: February 7, 2013 1:51 PM
> To: 'nali065@uottawa.ca'
> Cc: DEANGRAD; Sarah Charette
> Subject: RE: Procedure of appeal
>
> Good afternoon,
>
> Sarah Charette will respond to your email shortly.
>
> Cordially,
>
> Sonia Létourneau
> Tél. / Tel: 613-562-5800, poste / ext. 1234 Télec. / Fax: 613-562-5730
> sletourn@uottawa.ca
>

> intended recipient please notify us immediately by returning the message to the originator.
>
>
> -----Original Message-----
> From: nali065@uottawa.ca [mailto:nali065@uottawa.ca]
> Sent: 7 février 2013 13:40
> To: Sonia Letourneau
> Cc: 'nali065@uottawa.ca'; DEANGRAD; Sarah Charette
> Subject: Re: Procedure of appeal
>
> Sonia:
>
>
> Thank you for your response. Unfortunately it does not answer my
> questions addressed to the Dean. The policy on appeals for thesis
> evaluations states that appeals must be based on the grounds that "appropriate procedures"
> were not followed. I assume this means appropriate procedures for the
> evaluation of theses. Can you please provide me with any policy,
> regulation or procedure regarding the evaluation of theses? I
> understand that my appeal must be limited to any issue arising from a
> potential breach of those procedures. I look forward to hearing from you.
>
> Kind regards,
>
>
> Nicholas
>
>
>
>
> Dear Dr. Hastings:
>
> Re. your letter dated January 30th 2013, you referred me to paragraph
> 10 in the Appeal procedures. Paragraph 10 of the Appeal Procedure states:
>
> "Comprehensive examinations, thesis evaluations and thesis defences,
> being conducted by a panel of examiners in accordance with established
> procedures, are not subject to the appeal provisions of this regulation.
> Their decisions may, however, be appealed to the Executive Committee
> of the Faculty of Graduate and Postdoctoral Studies, which, depending
> on the nature of the complaint, will take appropriate action to ensure
> that it is clear that justice has been done. If the student is not
> satisfied with the outcome of such action, he may appeal to the Senate
> Appeals Committee on the grounds that appropriate procedures have not been followed."
>
> Questions:
> 1.   Can you please provide the established procedures mentioned in
> the first sentence of paragraph 10?, and
> 2.   Can you please provide the appropriate procedures mentioned in
> the last sentence of paragraph 10?
>
> In the event you are not able to address these questions, kindly
> direct me to the person I can contact to provide the information requested. Dr.
> Hastings I am grateful for your help with this matter.
>
> Kind regards,
>

>
> Nicholas
>
>
>
>
>
>> Good afternoon Mr. Ali,
>>
>> Dean Hastings has asked me to send you some information concerning
>> the procedure of appeal. Requests of appeal must be submitted within
>> 10 working days from receipt of the decision (in your case, the
>> deadline is Friday, February 15th). The documentation should be sent
>> to the office of the Assistant Dean and Secretary General, Dr.
>> Moriarty. The request of appeal will then be examined by the
>> Executive Committee of the FGPS. If your appeal is not granted, you
>> can submit a request of appeal to the Senate Appeals Committee.
>>
>> For any further information concerning the procedure of appeal, you
>> can contact Ms. Sarah Charette
>> (scharet2@uottawa.ca<mailto:scharet2@uottawa.ca>, extension 1223) at
>> the office of Dr. Moriarty.
>>
>> Sincerely,
>>
>> Sonia Létourneau
>> Secrétaire du doyen | Secretary to the Dean Faculté des études
>> supérieures et postdoctorales | Faculty of Graduate and Postdoctoral
>> Studies Pavillon Hagen Hall
>> 115 Séraphin-Marion (209)
>> Ottawa, ON K1N 6N5
>> Tél. / Tel: 613-562-5800, poste / ext. 1234 Télec. / Fax:
>> 613-562-5730 sletourn@uottawa.ca<mailto:sletourn@uottawa.ca>

>>
>>
>
>

Sonia Letourneau

From: DEANGRAD
Sent: 28 février 2013 16:59
To: 'nali065@uottawa.ca'
Subject: RE: Your decision

Dear Mr. Ali,

In response to your request (below), I have once again reviewed your case. I agree with you that there is a degree of ambiguity in The FGPS's regulation G.5.2.a(4). In your case, I based my decision on the following:

1. In your case, two of the examiners submitted a verdict of 3 (not acceptable for defence) – I therefore applied regulation G.5.2.a which states that "A thesis may not be defended if two examiners are opposed".
2. In your case, there was no majority: two gave a verdict of 3, one gave a verdict of 2 (though with a relatively critical report), and one gave a verdict of 1. The practice in such cases is to refer such cases to the Dean of the FGPS for a final decision (effectively, the Dean breaks the "tie"). In your case, I was not convinced by the reports of the two examiners who were favorable to going to defence, and so my decision was to close the file.

Yours sincerely,

Ross Hastings
Doyen| Dean
Faculté des études supérieures et postdoctorales |
Faculty of Graduate and Postdoctoral Studies
deangrad@uOttawa.ca
Téléphone / Telephone : (613) 562-5800 poste/extension 1234

-----Original Message-----
From: nali065@uottawa.ca [mailto:nali065@uottawa.ca]
Sent: 18 février 2013 20:00
To: DEANGRAD
Subject: Your decision

Dear Dr. Hastings:

Ref. Email dated Jan 20th, 2013
Ref. Letter dated Jan 30th 2013

In light of the above referenced communications, you have applied FGPS regulations G.5.2 (a) to arrive at your decision to withdraw me from my PhD program of studies. However, upon closer look at the previously referenced regulation, I found only one mention of mandatory withdrawal "A candidate whose thesis, following a second reading, is not recommended for the defence (a majority of verdicts 3 or 4) must withdraw from the program". In addition, the form for thesis examiner's report for a revised thesis states under verdict's 3 and 4 "If more than one examiner chooses this verdict for the revised thesis, the student must withdraw from the program." The two aforementioned mandatory

withdrawal clauses are inconsistent. As you know, I have received two verdicts of 3, a verdict of 2, and a verdict of 1, which does not consist of a majority of verdicts 3 or 4. Without a majority of verdicts 3 or 4, I request that you reinstate me in my program of studies. In the event you are exercising your discretionary reason(s), which to the best of my knowledge do not emanate from FGPS regulations, please provide me with these reason(s). I am, and will remain, very grateful for your consideration in this matter Dr.
Hastings.

Kind regards,

Nicholas Ali